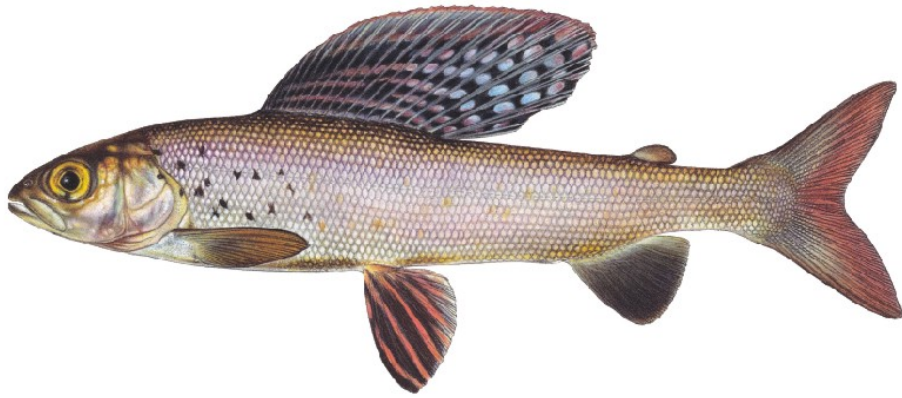


REINTRODUCING FLUVIAL ARCTIC GRAYLING
(*Thymallus arcticus*) TO THE UPPER RUBY RIVER, MT
A PROGRESS REPORT



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Wildlife & Parks***

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A PROGRESS REPORT

A Summary Report
Based on the efforts to reintroduce Arctic grayling to the upper Ruby River, MT

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TABLE OF CONTENTS

LIST OF TABLES.....	<u>iii</u>
LIST OF FIGURES.....	<u>iv</u>
SYNOPSIS.....	<u>v</u>
INTRODUCTION.....	<u>1</u>
Using remote site incubators to produce young of the year (yoy) fluvial Arctic grayling in the upper Ruby River	
INTRODUCTION.....	<u>4</u>
METHODS.....	<u>5</u>
RSI set up and site selection	<u>5</u>
Stream discharge and temperatures.....	<u>8</u>
Egg collection and distribution.....	<u>8</u>
Post hatch survival.....	<u>9</u>
RESULTS.....	<u>9</u>
Stream discharge and temperatures.....	<u>9</u>
Post hatch survival	<u>15</u>
DISCUSSION.....	<u>15</u>
A comparison of movement and habitat selection of Arctic grayling reared in a hatchery and a brood pond	
INTRODUCTION.....	<u>17</u>
METHODS.....	<u>18</u>
Surgically implanting transmitters and stocking of study fish.....	<u>18</u>
Tracking fish movement and habitat selection.....	<u>20</u>
RESULTS.....	<u>20</u>
Grayling movement patterns.....	<u>20</u>
Grayling habitat selection.....	<u>22</u>
DISCUSSION.....	<u>26</u>

Upper Ruby River grayling plants and Ruby River fish population monitoring

INTRODUCTION.....	<u>28</u>
METHODS.....	<u>29</u>
Fluvial Arctic grayling plantings.....	<u>29</u>
Fish population monitoring.....	<u>31</u>
RESULTS.....	<u>31</u>
Fish population monitoring.....	<u>31</u>
DISCUSSION.....	<u>39</u>
APPENDIX.....	<u>41</u>
Stream discharge and temperature data for the upper Ruby River (2003).....	<u>41</u>
ACKNOWLEDGMENTS.....	<u>44</u>
LITERATURE CITED.....	<u>45</u>

LIST OF TABLES

Using remote site incubators to produce young of the year (yoy) fluvial Arctic grayling in the upper Ruby River

Table 1. Estimates of the number of eggs incubated, the % survival, and location of the incubators	<u>10</u>
-----------------------------------------------------------------------------------------------------------------	-----------

A comparison of movement and habitat selection of Arctic grayling reared in a hatchery and a brood pond

Table 2. Demographics of study fish.....	<u>19</u>
-------------------------------------------------	-----------

Table 3. Summary of movement pattern data for BFTC and ALBP fish from Ruby River telemetry study.....	<u>21</u>
--------------------------------------------------------------------------------------------------------------	-----------

Upper Ruby River grayling plants and Ruby River fish population monitoring

Table 4. Summary of fluvial Arctic grayling plants in the upper Ruby River in 2003.....	<u>29</u>
------------------------------------------------------------------------------------------------	-----------

Table 5. Summary of spring sampling results from the upper Ruby River (2003).	<u>34</u>
--------------------------------------------------------------------------------------	-----------

Table 6. Summary of fall sampling results from the upper Ruby River (2003).....	<u>35</u>
----------------------------------------------------------------------------------------	-----------

Table 7. Summary of results for occurrence of whirling disease in rainbow trout within the upper Ruby River sampling sections (2003).....	<u>39</u>
--------------------------------------------------------------------------------------------------------------------------------------------------	-----------

LIST OF FIGURES

Using remote site incubators to produce young of the year (yoy) fluvial Arctic grayling in the upper Ruby River

Figure 1. Typical set up for locations with 5 incubators connected in series	<u>6</u>
Figure 2. Typical set up for locations with a single incubator.....	<u>6</u>
Figure 3. Spatial distribution of RSIs within the upper Ruby River drainage (2003).....	<u>7</u>
Figure 4. Hydrograph of spring runoff (2003 and POR) from the USGS gauge in the upper Ruby River.....	<u>11</u>
Figure 5. The intense spring runoff of 2003 increased turbidity levels throughout much of the upper Ruby River.....	<u>11</u>
Figure 6. The increasing current velocity and depth simply overwhelmed many of our incubators during the study.....	<u>12</u>
Figure 7. Mean daily temperatures at 6 RSI locations (2003).....	<u>13</u>
Figure 8. Mean stream temperatures at six RSI locations over the period 5-16-03 to 5-26-03.....	<u>13</u>
Figure 9. Cumulative degree-days at six RSI locations (2003).....	<u>14</u>
 A comparison of movement and habitat selection of Arctic grayling reared in a hatchery and a brood pond	
Figure 10. Spatial distribution of grayling locations during the 2003 Ruby River telemetry study	<u>23</u>
Figure 11. Movement patterns of BFTC and ALBP fish in the Ruby River telemetry study (2003).....	<u>24</u>
Figure 12. Habitat selection results for BFTC and ALBP fish from the upper Ruby River telemetry study (2003).....	<u>24</u>
Figure 13. Cover type selection results for BFTC and ALBP fish from the upper Ruby River telemetry study (2003).....	<u>25</u>
Figure 14. The variation in bank quality at locations for hatchery and brood pond fish from the upper Ruby River telemetry study (2003).....	<u>25</u>

LIST OF FIGURES (cont.)

Upper Ruby River grayling plants and Ruby River fish population monitoring

Figure 15. Fluvial Arctic grayling stocking locations within the upper Ruby River (2003).....	<u>30</u>
Figure 16. Seasonal sampling locations within the upper Ruby River (2003).....	<u>33</u>
Figure 17. Length frequency distribution of brown trout captured during spring sampling in the upper Ruby River (2003).....	<u>36</u>
Figure 18. Length frequency distribution of brown trout captured during fall sampling in the upper Ruby River (2003).....	<u>36</u>
Figure 19. Length frequency distribution of rainbow trout captured during spring sampling of the upper Ruby River (2003).....	<u>37</u>
Figure 20. Length frequency distribution of rainbow trout captured during fall sampling of the upper Ruby River (2003).....	<u>37</u>
Figure 21. Length frequency distribution of Arctic grayling captured during spring sampling of the upper Ruby River (2003).....	<u>38</u>
Figure 22. Length frequency distribution of Arctic grayling captured during fall sampling of the upper Ruby River (2003).....	<u>38</u>

Appendix

Stream discharge and temperature data for the upper Ruby River (2003)

Figure 23. Mean daily discharge data for the upper Ruby River (2003).....	<u>41</u>
Figure 24. Daily minimum stream temperatures collected from 9 locations in the upper Ruby River (2003).....	<u>41</u>
Figure 25. Daily maximum stream temperatures from 9 locations in the upper Ruby River (2003).....	<u>42</u>
Figure 26. Daily mean stream temperatures from 9 locations in the upper Ruby River (2003).....	<u>42</u>
Figure 27. Locations used for stream temperature monitoring in the upper Ruby River (2003).....	<u>43</u>

SYNOPSIS

The decision was made at 2002 Fluvial Arctic Grayling Workgroup meeting to focus efforts to expand the range of fluvial Arctic grayling in Montana on the upper Ruby River. We achieved this goal by: 1) conducting spring and fall fish population monitoring, 2) a study designed to produce young of the year Arctic grayling using remote site incubators, 3) planting approximately 37,000 fluvial Arctic grayling, 4) a study investigating and comparing the movement and habitat selection patterns of Arctic grayling raised in a hatchery and brood pond environments and stocked in the upper Ruby River, and 5) monitoring stream water temperatures and flows.

Spring population monitoring resulted in six Arctic grayling being captured from our sampling reaches. Four of these fish were mature adults preparing to spawn. Our remote site incubator study was a productive learning experience that yielded some positive results. While our first round of incubator trials had limited results due to an intense spring runoff, we did produce approximately 280 young of the year Arctic grayling from a single incubator installed after the peak of run off and set up to mimic natural spawning conditions. Our telemetry study results reconfirm that fluvial Arctic grayling show a preference pool habitats and use water depth as a source of cover. Our study fish were highly mobile, with fish moving as much as eight miles from release locations. We found a difference in the relative movement patterns of our experimental groups. Grayling reared at the Bozeman Fish Technology Center tended to move downstream while grayling reared at the Axolotl Lake brood pond tended to move upstream. Fall population monitoring resulted in 1,274 Arctic grayling being captured in our sampling reaches. Our hope is that a high percentage of these fish will survive the winter and form the foundation for a wild self-sustaining population of fluvial Arctic grayling in the upper Ruby River.

INTRODUCTION

The last fluvial Arctic grayling (*Thymallus arcticus*) population in the contiguous United States inhabits the Big Hole River in Montana. It has been determined that legal protection of this population under the Endangered Species Act (ESA) is warranted but precluded by higher priority species and current restoration efforts (Montana Fish, Wildlife and Parks (MFWP) and U.S. Fish and Wildlife Service (USFWS) Memorandum of Agreement (MOA) 1996). Currently, fluvial Arctic grayling is listed as a candidate species under the ESA. The state of Montana considers fluvial Arctic grayling a fish of “special concern” and has implemented an aggressive conservation and reintroduction program (Kaya 1992, Magee and Lamothe 2003). The current population range of fluvial Arctic grayling represents approximately 5% of its historic range. Expanding the range of this fish is currently a high priority of fluvial Arctic grayling restoration efforts in Montana.

In 1987, the Montana Fluvial Arctic Grayling Workgroup (FGW) was created to provide guidance on conservation efforts for the Big Hole fluvial Arctic grayling population, including the reintroduction of these fish throughout their historic range. Research conducted on the Big Hole population includes: population monitoring, identification of population limiting factors, investigations of fluvial Arctic grayling life history patterns, stream habitat inventories and improvement projects, stream water conservation projects, and the creation of a drought response plan. Outside of the Big Hole drainage, efforts include: the establishment of two brood ponds, (in order to protect the genetic integrity of Big Hole fluvial Arctic grayling and to provide gametes for reintroduction efforts), the development and establishment of a genetically variable brood

source derived from native Big Hole River grayling, rearing of Arctic grayling in state and federal fish hatcheries, and reintroduction attempts in the Sun River, Beaverhead River, Madison River, Missouri River, Gallatin River, Jefferson River and Ruby River drainages.

The upper Ruby River was identified as a potentially suitable stream for fluvial Arctic grayling restoration (Kaya 1992a), and reintroduction efforts began in 1997. The upper Ruby River was deemed suitable for fluvial Arctic grayling restoration due to its size, low gradient, and relatively low densities of non-native salmonids (Kaya 1992a). The upper Ruby River offers more than 40 miles of river that historically encompassed suitable grayling habitat (Kaya 1992a, Opitz 2000). The current perception is that the upper Ruby River continues to offer the best opportunity to restore a population of fluvial Arctic grayling by 2005 within its historic range (Kaya 1992a, Fluvial Arctic Grayling Workgroup (FGW), personal communication).

The objectives of the restoration effort in the upper Ruby River are to:

- 1) Attain stable to increasing population densities where natural reproduction equals or exceeds annual mortality for three consecutive years.
- 2) Monitor survival, movements, and densities of introduced grayling to determine biological factors affecting success of reintroduction efforts.
- 3) Attempt to monitor any natural reproduction.

In order to meet these objectives, MFWP has stocked the upper Ruby River with Arctic grayling on an annual basis since 1997. During the same period, multiple population monitoring sections were established and monitored using mobile electrofishing and mark-recapture techniques. Other methods used in the effort to restore

Arctic grayling to the upper Ruby River include: installation and monitoring of fish traps, a small scale project using remote site stream incubators, angler surveys, habitat inventories, and gill netting of Ruby Reservoir.

Due to the limited success in re-establishing multiple fluvial Arctic grayling populations at the same time, in 2003 the FGW decided to focus attention solely on the restoration efforts occurring within the upper Ruby River. This decision was reached because of previous success in restoration efforts within the upper Ruby River, namely the documentation of natural reproduction, and the need to focus resources, most notably hatchery-reared fish available for stocking and manpower.

The focusing of restoration efforts on the Ruby River led to 2003 being an intense work year that has led to some positive findings. The restoration effort of 2003 used the following multifaceted approach to continue restoration efforts:

- 1) The planting of approximately 37,000 hatchery and brood pond reared fluvial Arctic grayling,
- 2) Spring and Fall population monitoring through electrofishing surveys,
- 3) An intense effort (> 15 incubators) to produce young-of-the-year (yoy) Arctic grayling from gametes collected from adult grayling in brood ponds using remote site incubators,
- 4) An intense study of movement, habitat selection, and behavioral differences between hatchery and brood pond reared Arctic grayling, and
- 5) Monitoring of stream water temperatures and flows.

Using remote site incubators to produce young of the year (YOY) fluvial Arctic grayling in the upper Ruby River

Introduction

Remote-site incubators (RSIs) have been shown to be a successful method of producing salmonid fry from fertilized eggs in remote locations (Manny et al. 1989, Manuel et al. 1991, Donaghy and Verspoor 1999, Boltz and Kaeding 2002). RSIs are becoming a popular tool for fisheries managers due low cost and maintenance (Boltz and Kaeding 2002). RSIs can also be used as a bioassay for assessing the habitat quality of potential spawning grounds (Manny et al. 1989). Most recently RSIs have been used in an attempt to establish a lacustrine Arctic grayling broodstock in the Red Rock Lakes National Wildlife Refuge (Boltz and Kaeding 2002).

We used RSIs in the upper Ruby River during the spring of 2003 in an attempt to reintroduce yoy fluvial Arctic grayling to this portion of the drainage. RSIs were used because survival of stocked yoy fluvial Arctic grayling, in previous years had been unsuccessful (Opitz 2000). While natural reproduction of fluvial Arctic grayling within the upper Ruby River has been documented in 2000 and 2002, our data shows that it occurred at extremely low levels (Opitz 2000, Magee 2002).

This study was designed to help identify potential limiting factors to the natural reproduction of fluvial Arctic grayling within this drainage. The goals of our study were the identification of spatial variation in stream discharge, water temperature, egg, and post hatch juvenile survival.

Methods

RSI set up and site selection

We used 5-gallon incubators equipped with a single egg tray for the study. There were two set-up designs used during the study. Two site locations, just upstream of Basin Creek and Coal Creek, consisted of five incubators connected in series by a PVC manifold (Figure 1) (Figure 3). The remaining nine locations consisted of a single incubator (Figure 2) (Figure 3). Pools were created upstream of the incubators by damming the stream with rocks and plastic sheeting (Figure 2). The inflow consisted of PVC pipe (1") with a screen over the intake for the single units and 3" flexible hosing with screen over the intake for the five incubator setups. A PVC fitting at the top of the bucket served as outflow. Outflow from the incubators was checked daily and maintained at 3-4 gallons per minute (gpm). In 18 of the incubators the fertilized eggs were placed in the upper tray of the incubator and rocks were placed at the bottom the incubator to assist in stabilizing the unit. In one incubator (RSI # 11), gravel was placed in the bottom of the incubator and eyed grayling eggs were placed among the gravel.

RSIs were placed throughout the upper Middle Fork of the Ruby River and its tributaries (Figure 3). Sites were selected based on suitability for RSI installation. Site suitability parameters included stream discharge, depth, and availability of damming materials. Sites were also selected on the availability of suitable juvenile grayling habitat. This was an attempt to maximize post hatch survival.



Figure 1. Typical set up for locations with five incubators connected in series.

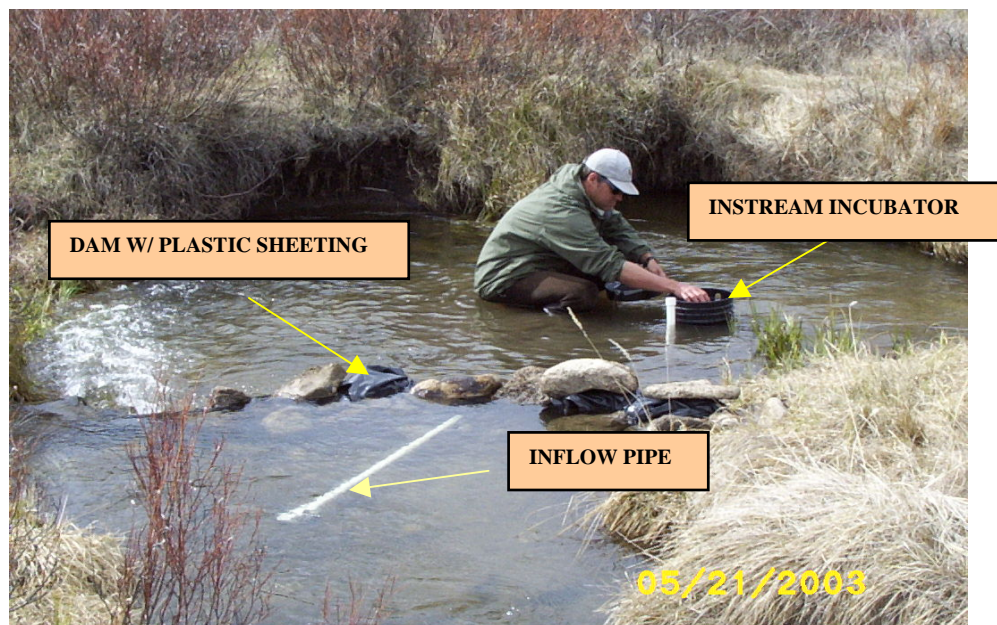


Figure 2. Typical set up for locations with a single incubator.

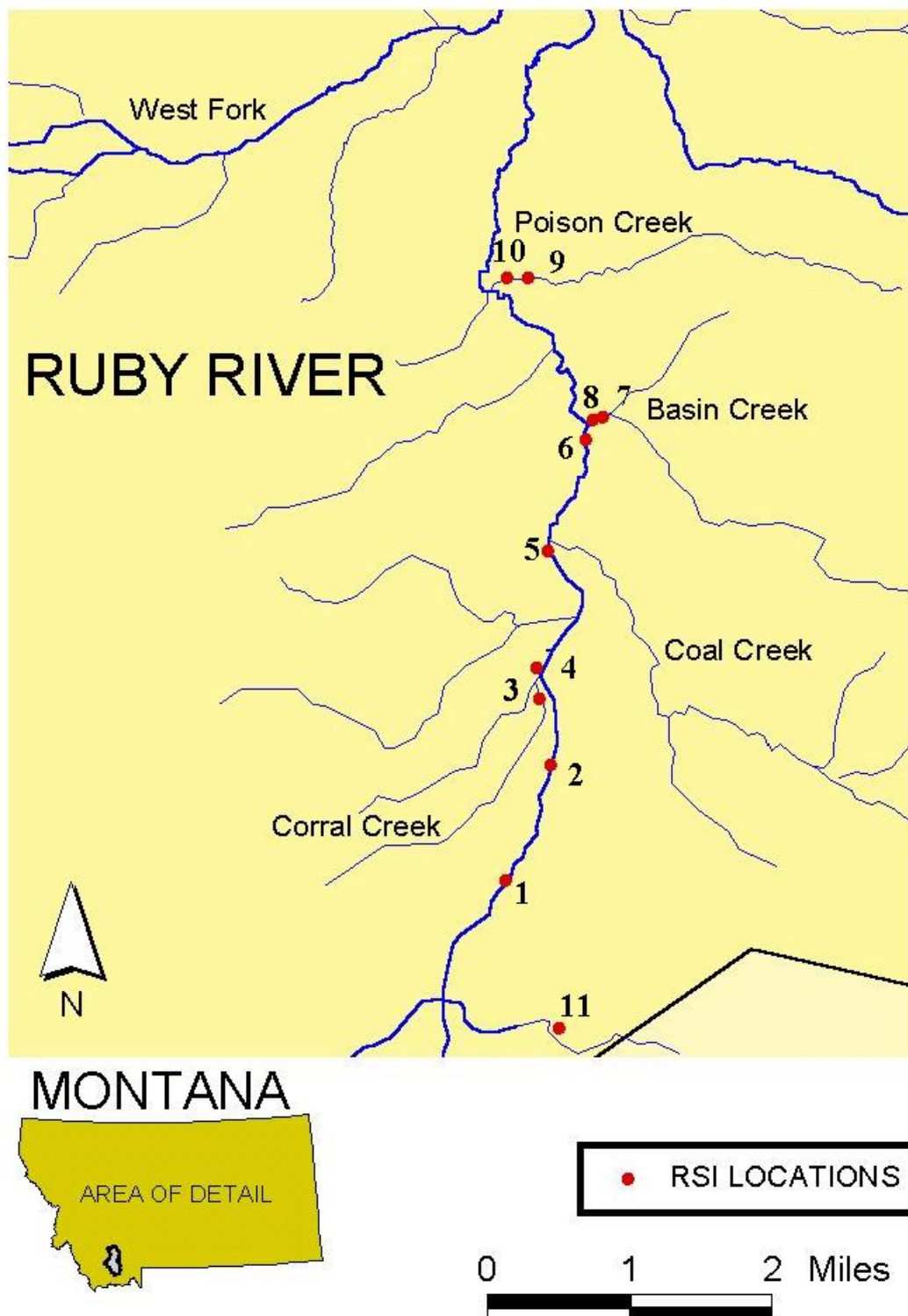


Figure 3. Spatial distribution of RSIs within the upper Ruby River drainage (2003).

Stream discharge and temperatures

Stream discharge was recorded at the United States Geological Survey (USGS) monitoring site # 6019500, approximately one mile upstream from Ruby Reservoir. Data was downloaded from the USGS website and entered into Microsoft Excel for analysis.

Onset temperature monitors were attached to incubators in six locations. Three were attached to incubators in the main channel of the Ruby River (RSIs 1, 2, and 5) and three were attached to incubators located in tributaries (RSIs 3, 7, and 9). Stream temperature was recorded hourly at each location. Data was entered in Microsoft Excel for analyzed for daily means and cumulative degree days. We also used analysis of variance (ANOVA) with Tukey's multiple contrast test for post hoc comparison of mean stream temperatures at the six locations.

Egg collection and distribution

Approximately 225,000 Arctic grayling eggs were collected from the brood reserve at Green Hollow II on Turner Enterprises' Flying D Ranch on May 15, 2003. Eggs were stripped from females, pooled, and fertilized with milt from males. Fertilized eggs were water hardened and transported to the Dillon Field Office. The following morning fisheries personnel transported the eggs to the upper Ruby River. We treated the eggs in an iodine bath and distributed them among the 18 incubators (RSI locations 1-10, Table 1).

On May 29, 2003, 30,000 eyed grayling eggs, spawned at the Axolotl Lake brood pond, and were transported to the upper Ruby River from the Big Springs Hatchery in Lewistown. We distributed the eggs among one incubator (RSI location 11, 1,400 eggs, Figure, Table 1) and seven instream egg baskets. Egg densities within the baskets ranged

from 400 to 11,200 eggs. We placed five baskets in the headwaters of Pocket Creek, one basket in Basin Creek and one basket in the unnamed tributary just upstream of RSI location 11.

Post-hatch survival

We used visual counts and backpack electroshocking techniques during Fall 2003 to determine survival rates of yoy grayling hatched from incubators and egg baskets. Stream sections were surveyed both upstream and downstream of incubator and egg basket locations. Captured grayling were anesthetized in Tricaine Methanesulfonate (MS-222) and measured for total length (± 0.01 in.). We recorded capture locations with a GPS unit to determine the extent of upstream or downstream dispersal from incubator locations.

RESULTS

Stream discharge and temperatures

The 2003 spring runoff in the upper Ruby River peaked earlier and was nearly double in intensity relative to spring runoff data over the 64-year period of record (POR) (Figure 4). Intensity of the runoff impacted the effectiveness of the incubators in two ways. First, the high flows increased the sediment load of the stream causing incubator intakes to clog and decrease the flow of water through the incubator and causing eggs to be covered with fine sediment. Second, as flows peaked, the increase in depth and current velocity overwhelmed the stability of the incubators causing them to dislodge from their stream location and many of the eggs were deposited into the torrent with little hope of survival. The combined effects of the runoff caused a total failure of the original 18 incubators to produce grayling yoy.

Table 1. Estimates of the number of eggs incubated, the % survival, and location of the incubator.

RSI LOCATION(#)	# OF EGGS	SURVIVAL(%)	LOCATION
1	7700	0	MIDDLE FORK RUBY
2	7000	0	MIDDLE FORK RUBY
3	8400	0	CORRAL CREEK
4	16100	0	CORRAL CREEK
5	15000	0	MIDDLE FORK RUBY
5	12000	0	
5	10000	0	
5	8000	0	
5	5000	0	
6	25000	0	MIDDLE FORK RUBY
6	20000	0	
6	15000	0	
6	10000	0	
6	5000	0	
7	15000	0	BASIN CREEK
8	15000	0	BASIN CREEK
9	15000	0	POISON CREEK
10	15000	0	POISON CREEK
11	1400	20	UNNAMED TRIB

We did produce approximately 280 yoy grayling from incubator #11 (Table 1). We attribute the success of this location to the use of eyed eggs, the eggs being in the incubator after the peak of runoff, and the incubator being set up to mimic natural spawning conditions.

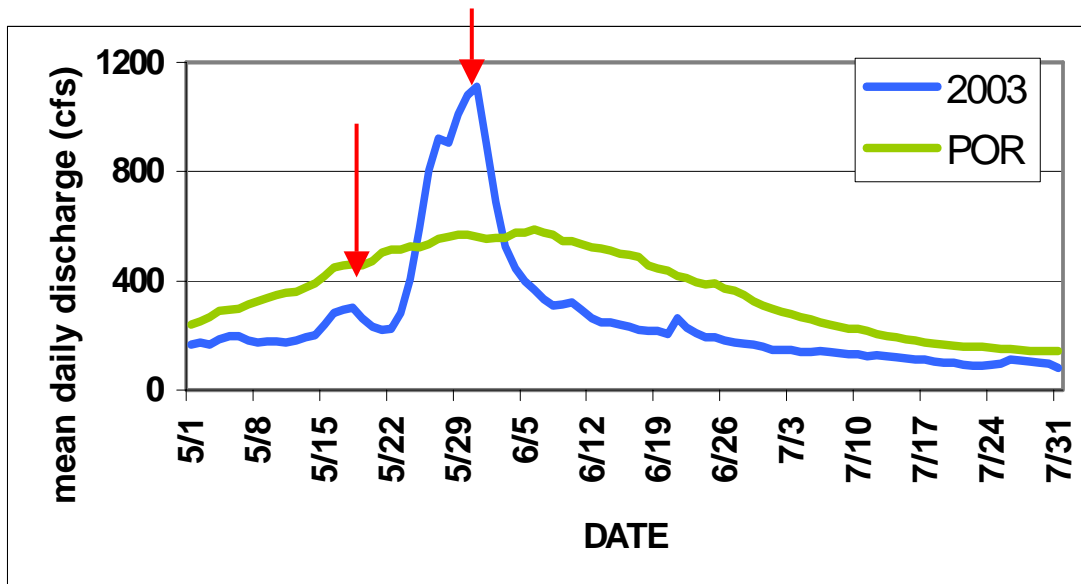


Figure 4. Hydrograph of spring runoff (2003 and POR) from the USGS gauge in the upper Ruby River. The red arrows indicate dates that grayling eggs were deposited into incubators.

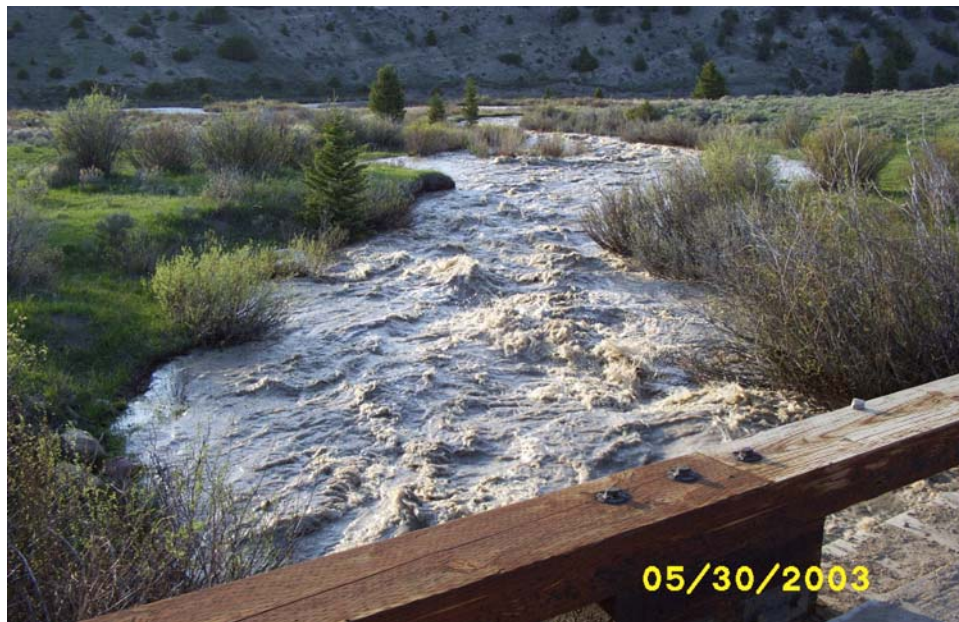


Figure 5. The intense spring runoff of 2003 increased turbidity levels throughout much of the upper Ruby River.



Figure 6. The increasing current velocity and depth simply overwhelmed many of our incubators during the study.

Daily mean temperatures over the period of the study are shown in Figure 7. We found significant differences among the RSI locations for mean temperatures (ANOVA, $p < 0.0001$) (Figure 8). Mean temperatures were significantly highest at RSI location # 5. Mean temperatures were significantly lowest at the RSIs placed within the tributaries of Basin Creek and Poison Creek (Figure 8).

Degree days are an important determinant of time to hatching for Arctic grayling eggs (Tryon 1947, Bishop 1971, Kratt and Smith 1977). Estimates from these studies show time from egg fertilization to spawning ranges from 176.75 (Kratt and Smith 1977) to 291.9 degree-days (Tryon 1947). The cumulative degree days at 6 RSI locations is shown in Figure 10.

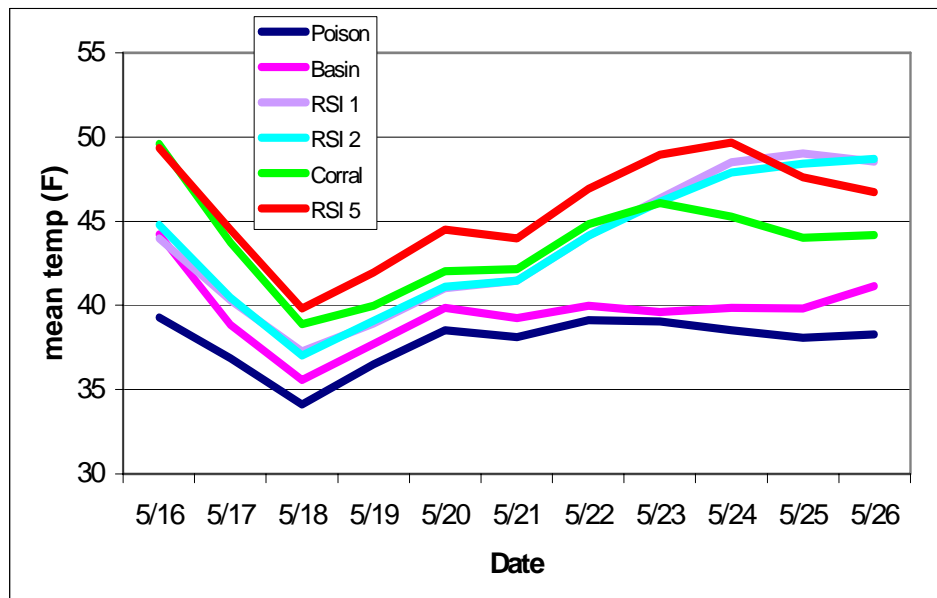


Figure 7. Mean daily temperatures at 6 RSI locations (2003).

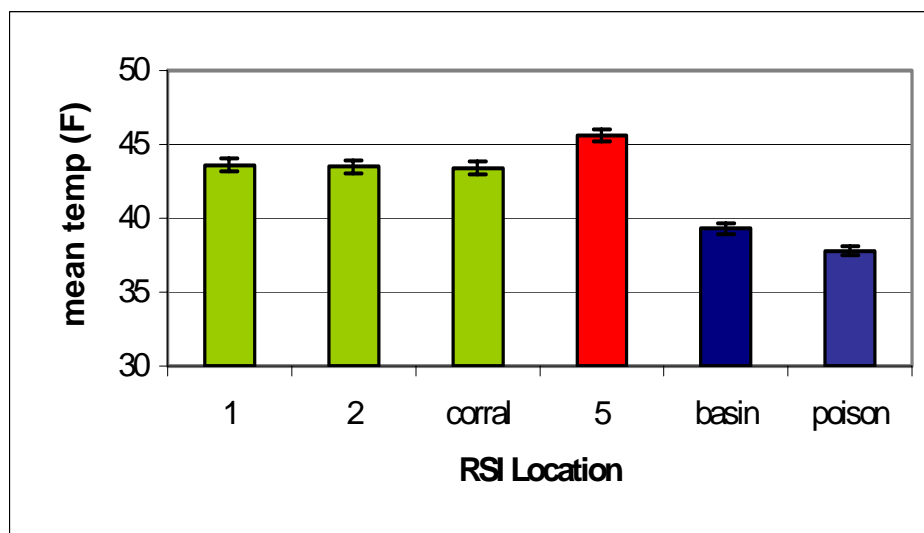


Figure 8. Mean stream temperatures at six RSI locations over the period 5-16-03 to 5-26-03. Colors represent statistical groupings based on Tukey's multiple contrast test.

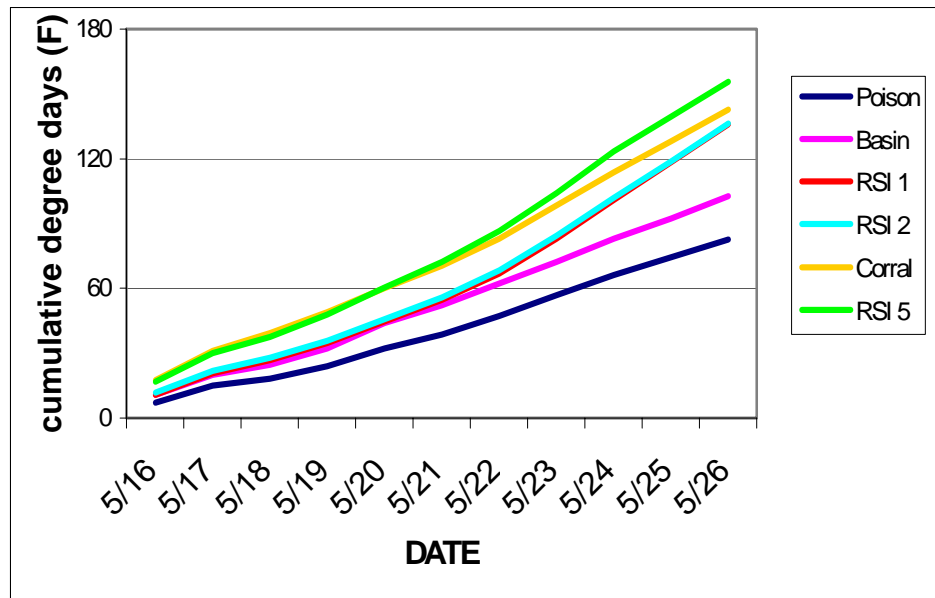


Figure 9. Cumulative degree-days at six RSI locations (2003).

Cumulative degree-days ranged from 82.8 at the RSI in Poison Creek to 155.6 at the RSI #5. With an average accumulation rate of 14.1 degree-days per day, the eggs at RSI location # 5 should have been ready to hatch on May 28 using the 176.75 value for hatching from Kratt and Smith (1977). Other observed values for degree-days to hatching include: 216.5 (Bishop 1971) and 250 (Rawson 1950, Ward 1951). Daily observations showed that while some egg development had occurred, none of the eggs were close to hatching. There are many possible explanations for this observation including mortality from over handling, possible mortality from treating with iodine prior to the eyed stage (Brown and Shrable 1994, Boyce 2003), and excessive fine sediment build-up in the incubators.

Post-hatch survival

On June 11, 2003 we released approximately 250 yoy Arctic grayling into the headwaters of the middle fork of the Ruby River from RSI location #11 (Figure 3). Another 30 yoy Arctic grayling were observed downstream of the RSI. A small number (< 30) of yoy were produced from the egg trays in Basin Creek and Pocket Creek. Backpack electrofishing surveys conducted in the fall resulted in 50 yoy grayling being captured downstream of RSI #11. No yoy grayling were captured in other locations surveyed. The average length of these fish was 3.8 in. with a range of 2.8 to 4.7 in. Our surveys indicate that these fish had dispersed a maximum of 1.5 miles downstream of the incubator into a small pond created by beaver activity. No individuals were captured upstream of the incubator.

Discussion

The lessons learned from the 2003 Ruby River incubator study will provide us with the information and techniques necessary to successfully produce yoy grayling from RSIs on an annual basis. The successful production of wild yoy grayling will be a major component to restore fluvial Arctic grayling in the upper Ruby River. If this production does not lead directly to the reestablishment of fluvial grayling, it should help to identify current limiting factors to Arctic grayling, especially juveniles, within the drainage.

In future efforts, we believe only grayling eggs in the eyed stage of development should be placed into incubators. Using eyed eggs will reduce the amount of time of development and should reduce the eggs vulnerability to high flows and sediment loads. We learned many lessons about the set up and maintenance of the incubators. In the future, we would simulate natural spawning conditions by spreading low densities of

eggs (< 5000) on top of gravels placed on the bottom of the incubator. We also believe that incubators should be handled as little as possible. While incubators may need to be visually checked for adequate flow on a daily basis, the removal of dead or diseased eggs should be completed with minimal handling. We believe overhandling of eggs was a major cause of mortality in the incubators prior to the intense runoff that ended the first round of the study.

The placement of RSIs should be limited to upper Ruby River and its tributaries above the mouth of Basin Creek. This recommendation is based on observed flows and temperatures during the 2003 study. The ideal locations appear to be within Corral Creek and the middle fork of the Ruby River upstream of Corral Creek. While RSI location # 5 had warmer temperatures, we believe the relatively high sediment loads associated with this downstream location create less than optimal conditions and should be avoided in the future.

A comparison of movement and habitat selection of Arctic grayling reared in a hatchery and a brood pond

Introduction

Fluvial Arctic grayling have been stocked into a number of waters throughout Montana in an attempt to expand the current range of this fish. These efforts are part of a restoration plan aimed at preserving and expanding the range of Big Hole River fluvial Arctic grayling. To date, none of the reintroduction efforts have been completely successful. While post-stocking sampling has occurred, these efforts often occur months after the fish are stocked, and while information about the movement and habitat selection patterns of stocked fish can be extracted from these data, little is known about the behavioral patterns of these fish immediately after stocking.

Liermann (2001) attempted to quantify the macro-scale (> 6 mi.) movements of stocked grayling in the upper Ruby River. The data collected shows that downstream movements of these fish averaged approximately 1.65 mi. between the two years of the study. Pool and run to riffle ratio was found to be a significant predictor of grayling abundance during the study. This suggests that post-stocked grayling were selecting these habitat types and these results agree with previous studies of Arctic grayling habitat selection (Lamothe and Magee 2002).

While Liermann (2001) found limited downstream movements of stocked grayling, subsequent MFWP electrofishing surveys have found grayling as far downstream as the USGS stream gauging site (approximately 38 river miles downstream of the Three Forks Cow Camp, a traditional stocking site). A grayling was also documented in Ruby Reservoir during 2002 ice fishing angler surveys (Oswald, personal communication). Movement of high numbers of grayling downstream into a reservoir is

believed to cause a shift from fluvial to adfluvial behaviors and can jeopardize the success of a reintroduction project.

In order to understand the behavioral patterns of fluvial Arctic grayling immediately after being stocked into the upper Ruby River, the following objectives were established for this study: 1) to quantify the movements of Arctic grayling stocked into the upper Ruby River, 2) to quantify the habitat selection of Arctic grayling stocked in the upper River, and 3) to compare the movement and habitat selection patterns between Arctic grayling raised in hatchery and brood pond environments.

Methods

Surgically implanting transmitters and stocking of study fish

We used nine Arctic grayling from the Bozeman Fish Technology Center (BFTC) and 11 Arctic grayling from the Axolotl Lake brood pond stock (ALBP) for the study. The study fish from ALBP were captured using hook and line techniques. The surgical procedures used for implanting the transmitters into the BFTC and the ALBP study are described in Lamothe and Magee (2002). The transmitters weighed 2.5 grams and were programmed to operate on a schedule of 12 hours on and 12 hours off in order to extend battery life. On June 10, 2003 the study fish, and approximately 1,500 grayling raised for stocking purposes, were transported from the BFTC in a hatchery truck, equipped with aerated tanks, to the upper Ruby River. The nine study fish from the BFTC were divided in to two groups. We released five Arctic grayling with implanted transmitters near the mouth of Corral Creek along with approximately 750 hatchery grayling in order to simulate stocking conditions. The other release site used in the study was just upstream of the Three Forks Cow Camp. At this site we released four study fish and another 750

hatchery grayling. The 11 ALBP study fish were transported to the Ruby River in the same manner as the BFTC fish. On June 24, 2003 we released the 11 ALBP fish at the Three Forks release site along with another 200 Arctic grayling captured from Axolotl Lake. Again, this was done in an attempt to simulate stocking conditions. We did not split the group and use the Corral Creek release site due to low number of fish available for stocking. The demographics of the study fish are shown in Table 2.

Table 2. Demographics of study fish.

FREQUENCY	LENGTH(in.)	WEIGHT(lb.)	SEX	CAPTURE LOCATION
148.320	10.9	0.32	M	ALBP
148.340	10.4	0.36	M	BFTC
148.360	10.5	0.45	F	BFTC
148.380	10.7	0.44	M	BFTC
148.400	11.1	0.47	F	BFTC
148.420	10.2	0.40	M	BFTC
148.440	10.3	0.32	F	ALBP
148.460	10.3	0.36	F	BFTC
148.480	10.9	0.44	F	BFTC
148.500	11.1	0.47	M	BFTC
148.520	11.2	0.46	M	BFTC
148.540	11.7	0.42	M	ALBP
148.560	12.0	0.50	M	ALBP
148.580	12.4	0.42	M	ALBP
148.600	11.0	0.32	F	ALBP
148.620	10.3	0.32	M	ALBP
148.640	10.6	0.32	M	ALBP
148.660	10.9	0.34	M	ALBP
148.680	10.4	0.35	F	ALBP
148.700	10.7	0.32	F	ALBP

The study fish averaged 10.9 inches in length and weighed an average 0.39 pounds. We found no significant differences in length between the ALBP and BFTC fish (t-test, $p=0.27$). Not surprisingly, we did find significant differences in weight between the two

groups (t-test, $p=0.01$). We attribute this difference to the relatively high food availability and restricted mobility of the hatchery fish.

Tracking fish movement and habitat selection

We tracked the study fish on foot with a Lotek SRX 400 telemetry receiver. We collected data from 206 observations on 22 days over the period June 11 to September 4, 2003. When grayling were located, the UTM coordinates were recorded along with habitat unit, water temperature, available cover type, stream bank quality, and water depth. Stream bank quality assessment was subjective and was ranked as high, medium, or low quality. Data was entered into Microsoft Excel, Arcview 3.2, and SAS software for analysis.

Results

Grayling movement patterns

The spatial distribution of movement for the study fish is shown in Figure 10. The longest movements recorded for a study fish was from the Three Forks release site downstream approximately eight miles to Bull Creek (Figure 10). Subsequent MFWP fall fish population monitoring data shows that fish stocked in the upper Ruby River in 2003 had moved as much as 48 miles. The difference in these distances may be attributed to the timing of stocking since they were the last of 37,000 fish stocked into the system. The high densities of stocked fish downstream of Three Forks may have made the lower reaches of the Ruby River “unattractive” to our study fish.

We found no statistical differences in mean distance moved between the BFTC and ALBP (Table 3). This suggests that the magnitude of movements between the two groups was not different. We did find statistical differences in the mean relative distance

moved between the BFTC and ALBP fish (Table 3). ALBP fish for the most part moved upstream while the BFTC fish moved in a downstream direction (Figure 11).

We found nine transmitters during the study that had been expelled from the study fish. At five of these locations, we found signs of predation. The transmitters were located in predator dens on two occasions and were not retrievable. Discussions with hatchery personnel and the results from previous telemetry studies (Lamothe and Magee 2002) suggest that Arctic grayling are not the ideal candidate for this type of study due to its vulnerability to infection. While nine of the fish did expel their transmitters or succumb to predation, we do not believe this affected the integrity of our results. Visual observations showed that study fish were often mixed in with other Arctic grayling at relocation sites. We know that our maximum movement estimates were conservative due to our fall sampling results. We suggest that future studies use telemetry techniques that avoid the invasive surgery required for the use of internal transmitters. If possible, movement studies could be designed without the use of telemetry techniques all together and this would avoid the possibility of studying unhealthy study fish and also avoid the limitations of the small sample sizes often associated with telemetry studies.

Table 3. Summary of movement pattern data for BFTC and ALBP fish from Ruby River telemetry study.

Parameter	BFTC	ALBP	p-value
distance (mi.)	0.15	0.13	0.71
relative distance (mi.)	0.13 (downstream)	0.06 (upstream)	0.006

Grayling habitat selection

As in previous studies, our observations show that Arctic grayling selected pool habitats in the upper Ruby River (Figure 12). Our results show that 85% of observations of BFTC fish and 79% of observations of ALBP fish were made in pool habitats (Figure 12). Our data show that the study fish selected water depth as a cover type in a majority of our observations (Figure 13). BFTC fish selected water depth as cover in 79% of our observations and ALBP pond fish selected water depth as cover in 56% of observations. The average depth at locations for all observations during the study was 3.1 feet.

Our data show that BFTC fish were found most often in locations with high quality banks (52% of our observations), while ALBP pond fish were found most often in locations with medium quality banks (61% of our observations) (Figure 14). ALBP pond fish were found in locations with low quality banks in 13% of our observations. This observation is a result of these fish moving upstream from the Three Forks release site. The area between Three Forks and Poison Creek has a history of heavy grazing pressure (personal observation).

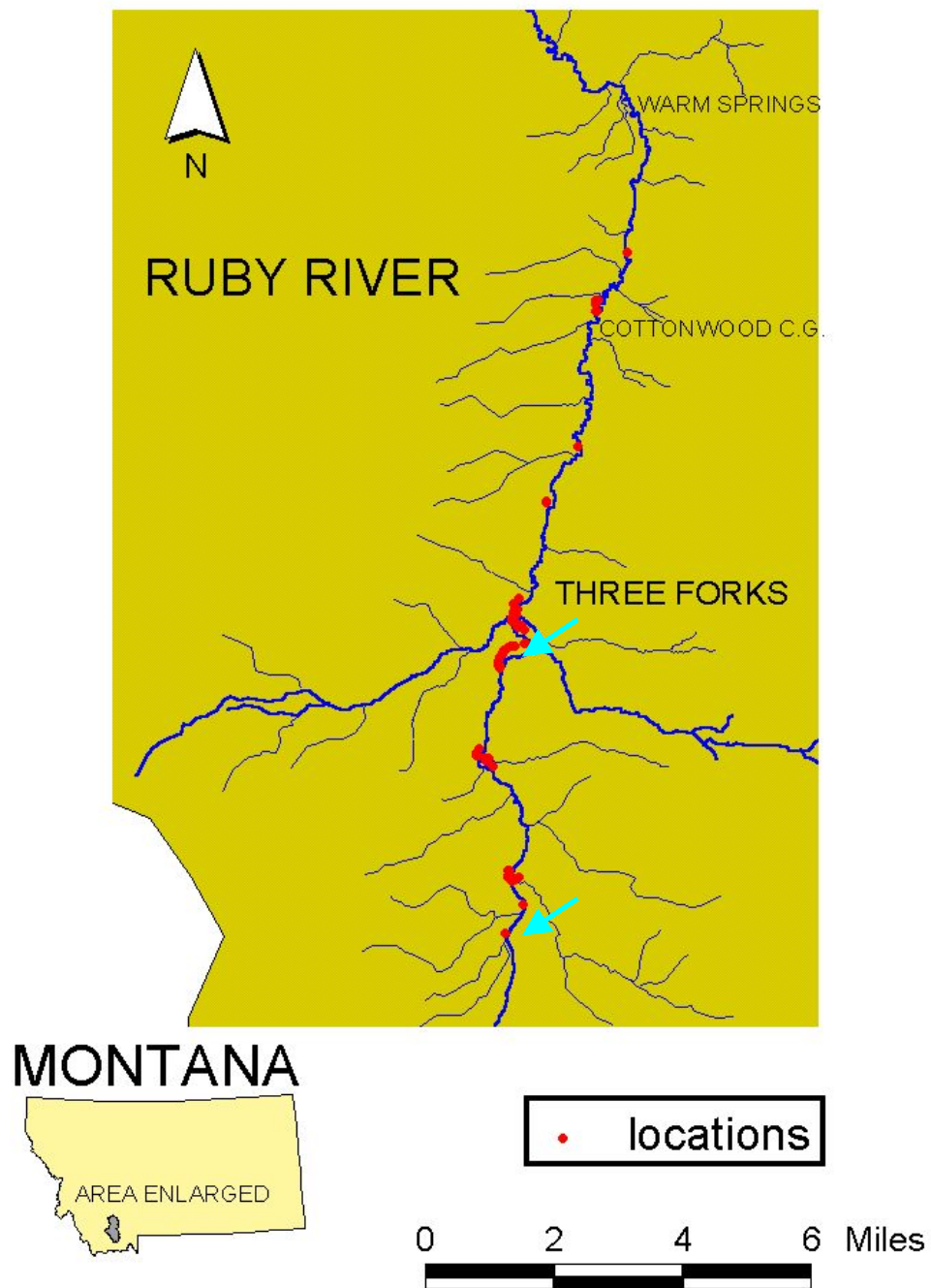


Figure 10. Spatial distribution of grayling relocations during the 2003 Ruby River telemetry study. Arrows indicate release locations.

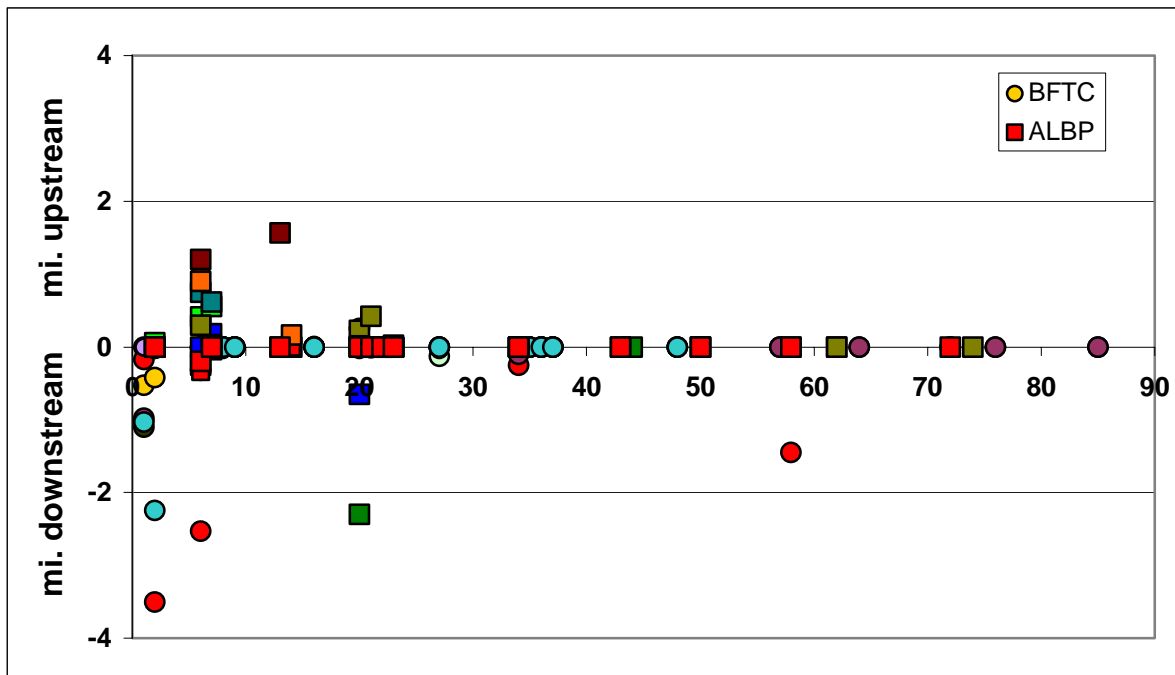


Figure 11. Movement patterns of BFTC and ALBP fish in the Ruby River telemetry study (2003). Squares represent ALBP fish and circles represent BFTC fish. Colors represent individual fish.

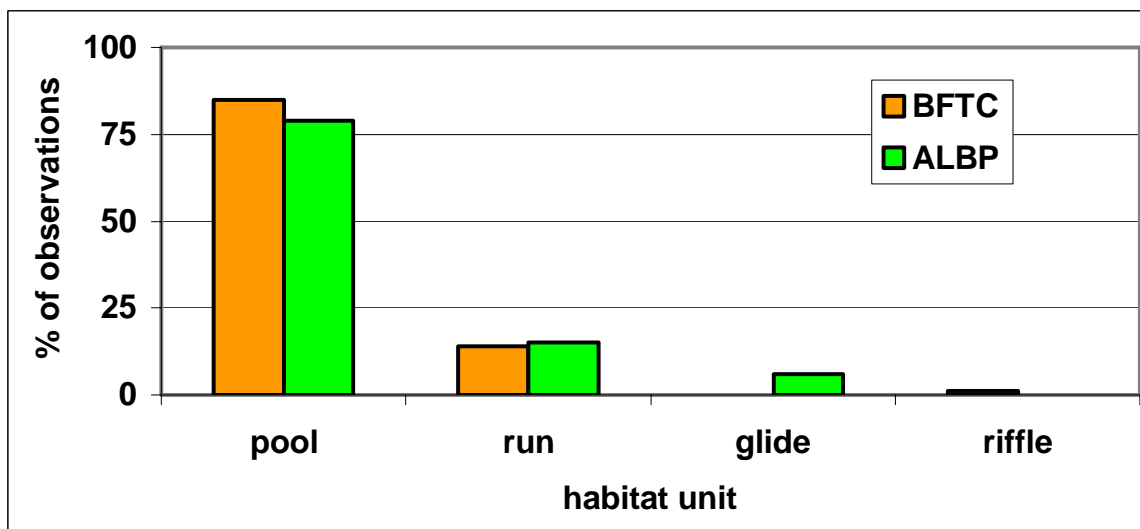


Figure 12. Habitat selection results for BFTC and ALBP fish from the upper Ruby River telemetry study (2003).

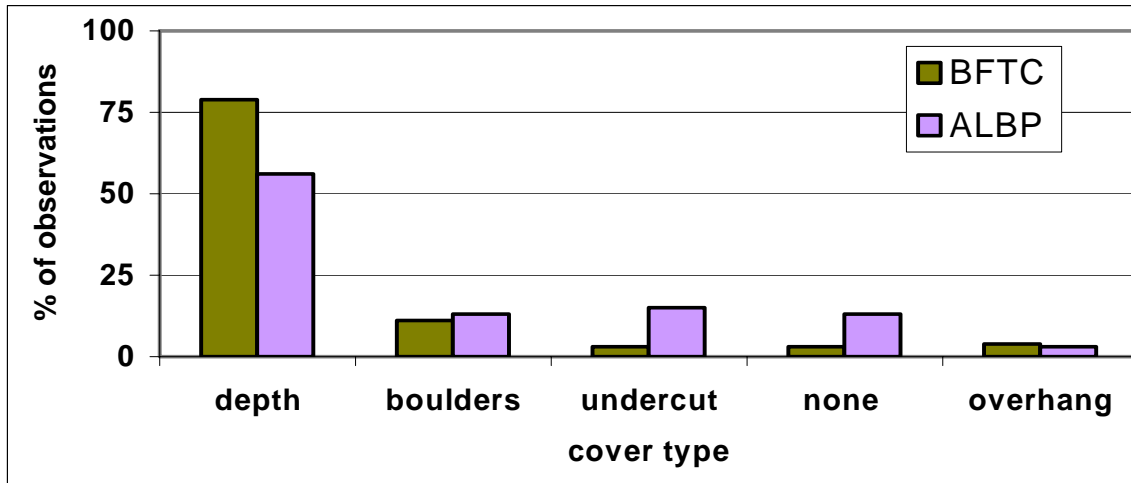


Figure 13. Cover type selection results for BFTC and ALBP fish from the upper Ruby River telemetry study (2003).

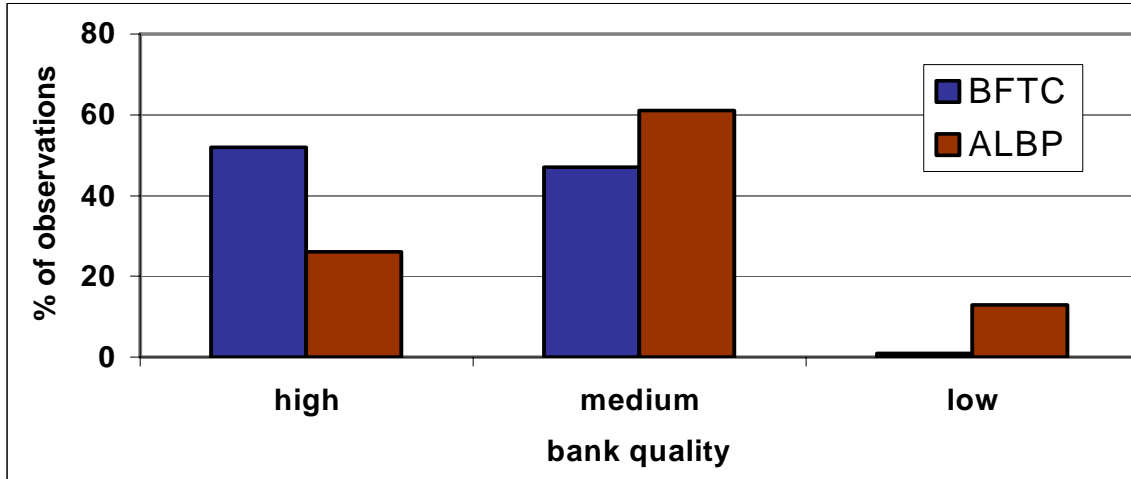


Figure 14. The variation in bank quality at locations for hatchery and brood pond fish from the upper Ruby River telemetry study (2003).

Discussion

This study has generated many interesting results. The most important of these is the movement pattern comparison of the ALBP fish and the BFTC fish. The difference in the movement patterns of these fish may be explained by the differences in time of release, associated stocking densities, or possibly rearing environment. The release dates of the two experimental groups was separated by two weeks. The release dates coincide with the descending limb of the hydrograph and the relatively low flows experienced by the ALBP fish may have allowed them to move upstream (See Figure 23 in the appendix). The ALBP study fish were also released along with relatively small numbers of fish (200) and this difference may have allowed this group of fish to orient themselves and move upstream. The ALBP study fish were also the last of 37,000 fish stocked into the upper Ruby River in 2003. The high densities of stocked fish downstream of the Three Forks release site (personal observation) may have made it “unattractive” for the ALBP study fish to move downstream. The differences in rearing environment between the two experimental groups is extreme. ALBP fish spend their days swimming around a mountain pond and the BFTC fish are restricted to small rearing tanks within the hatchery. Is it possible that these differences in rearing environment resulted in the differences in movement pattern between the two groups? Are these differences permanent or does it just take fish reared in a hatchery environment longer to get their “legs” under them?

The habitat selection patterns of the Ruby River study fish were similar to the results from our 2001 and 2002 Big Hole River telemetry study (unpublished data, Lamothe and Magee 2002). The importance of high quality pools to Arctic grayling is a

common theme to all these studies. The ultimate success of this reintroduction effort may depend on our ability to protect and improve the pool habitat of the upper Ruby River. The section of river upstream of Poison Creek seems to have high numbers of high quality pools, most associated with beaver activity, but most areas of the river have habitats that could be improved.

Upper Ruby River grayling plants and Ruby River fish population monitoring

Introduction

The stocking of the upper Ruby River with fluvial Arctic grayling began in 1997 (Opitz 2000). The stocking of progeny from the Big Hole River fluvial Arctic grayling population has been a major component of the reintroduction plan for these fish since 1997. To this date MFWP has attempted to reintroduce fluvial Arctic grayling to the upper Ruby River, the lower Beaverhead River, the Sun River above Gibson Reservoir, the Missouri River, the Madison River, the Gallatin River, and the Jefferson River. To this point the success of these attempts has been minimal. Possible explanations for this limited success are: 1) the extended period of drought currently affecting Montana, 2) the limited numbers of fish available for planting, and 3) the presence of dams and reservoirs in many of the potential reintroduction drainages.

While the reintroduction effort has fallen short of its ultimate goal of establishing stable, naturally reproducing populations, efforts within the upper Ruby River have yielded some positive results. The documentation of limited natural reproduction from post-stocking population monitoring being the most encouraging of these results. Monitoring of the fish populations within the reintroduction locations is a critical component of our efforts. The seasonal population monitoring provides information about: 1) post-stocking survival, 2) movement from stocking locations, 3) spawning success, and 4) impacts that the stocking of high numbers of fluvial grayling may be having on the resident fish populations.

Methods

Fluvial Arctic grayling plantings

MFWP stocked approximately 37,000 fluvial Arctic grayling into the upper Ruby River in 2003. We distributed the fish among 8 locations within the upper Ruby basin (Figure 15). All stocking locations were upstream of Vigilante Station (Figure 15). A majority of the fish (approximately 33,000) were raised and transported from Blue Water State Fish Hatchery (Table 4). This was the first year that fish were stocked in large numbers upstream of the Three Forks Cow Camp. The decision to alter our historic stocking locations was made due to poor post-stocking survival in previous years and the relatively high quality habitat found in the upper river above Three Forks.

Table 4. Summary of fluvial Arctic grayling plants in the upper Ruby River in 2003.

DATE	HATCHERY	# OF FISH	AGE
5-5-03	BLUE WATER STATE HTCHRY	8032	1
5-7-03	BLUE WATER STATE HTCHRY	7420	1
5-12-03	BLUE WATER STATE HTCHRY	8566	1
5-14-03	BLUE WATER STATE HTCHRY	6675	1
5-27-03	BLUE WATER STATE HTCHRY	2628	1
6-10-03	BOZEMAN FISH TECH CTR	1475	2
6-26-03	BOZEMAN FISH TECH CTR	2179	1
	TOTAL	36975	

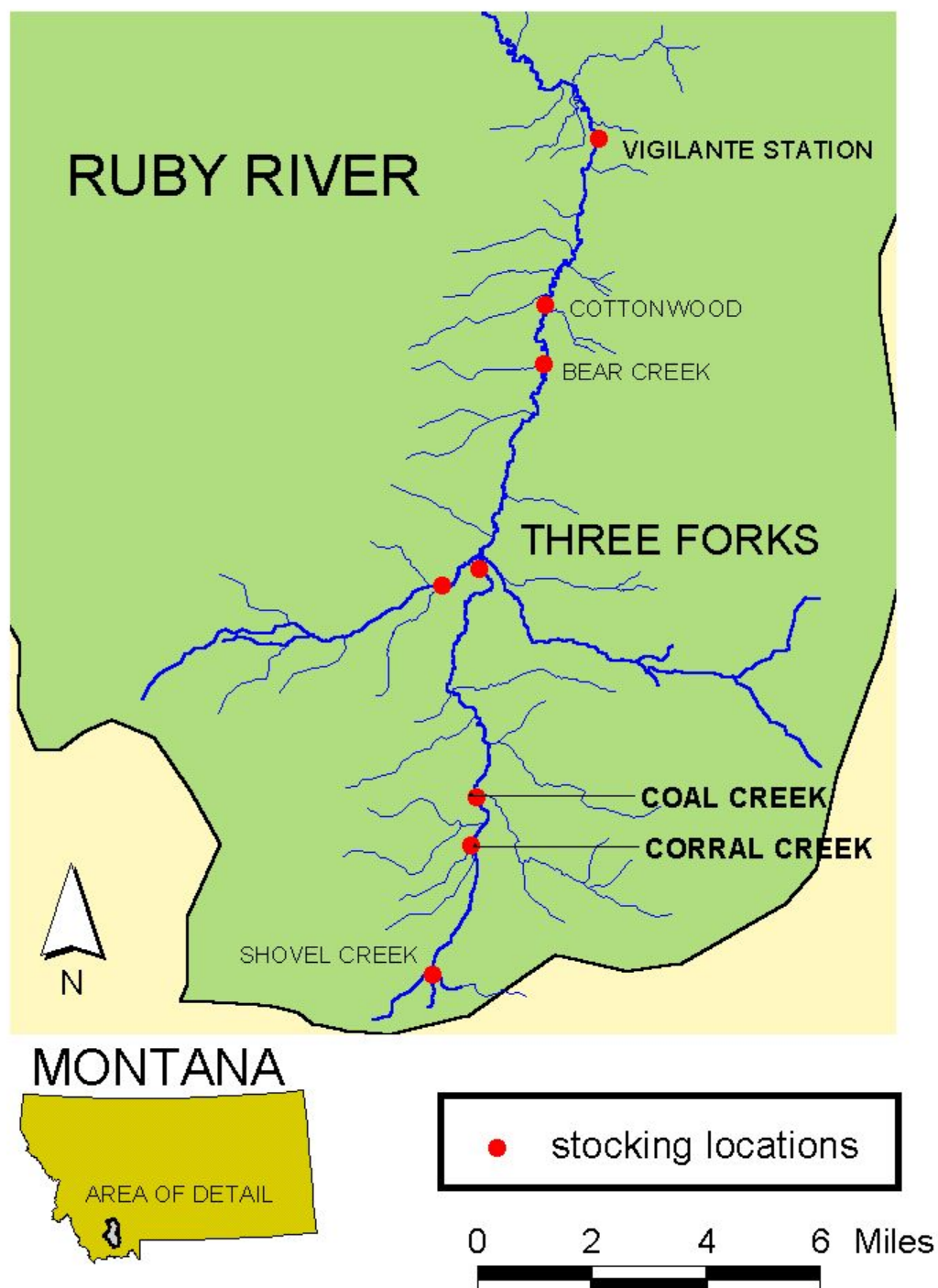


Figure 15. Fluvial Arctic grayling stocking locations within the upper Ruby River (2003).

Fish population monitoring

We sampled the Ruby River upstream of the reservoir during the spring and fall of 2003. We electrofished with a mobile-anode DC system powered by a 4,000 watt generator. The generator is coupled to a Coffelt Mark XXII-M rectifying unit mounted on a drift boat or a Coleman Crawdad. The upper reaches of the middle fork of the Ruby River were sampled with a Smith-Root backpack electroshocker. Two or three-man teams were used for sampling. Target species were captured and held in a live well. We anesthetized fish for processing in a Tricaine Methanesulfonate (MS-222) bath, measured total length (± 0.1 in.) and weight (± 0.01 lb.), marked and collected scales. We also recorded the number of fish with scarring caused by being caught by an angler (i.e; hook scars) and the number of fish with deformed heads. Deformed heads are an indicator of whirling disease and occur most often in rainbow trout. For the sake of brevity, rainbow trout and rainbow trout X cutthroat trout hybrids were lumped in our results as rainbow trout. We selected a number of sites to sample seasonally to ensure that our data represents the seasonal and spatial variation that exists in the fish populations of the upper Ruby River (Figure 16).

Results

Fish population sampling

Our spring and fall electrofishing sampling results are summarized in Tables 5-7 and Figures 17-22. While our spring sampling resulted in only six Arctic grayling being captured (Table 5), four of these fish were sexually mature and one was a female with eggs. Our fall sampling resulted in 1,274 grayling being captured within our study sections. We found Arctic grayling distributed throughout the upper Ruby River. We

captured low numbers of Arctic grayling (3) in the Upper Maloney section, which is our extreme downstream section, and strong numbers of Arctic grayling (53) in our Headwaters (HDWTRS) section (Figure 16). The Headwaters section is the farthest upstream section that we sampled and a majority of the fish we captured were young of the year grayling spawned from remote site incubators.

The presence of whirling disease, as indicated by the number of fish with deformed heads, remains high in the upper Ruby River. Our results show that 60% of the rainbow trout in the Canyon section had deformed heads (Table 7). We observed rainbow trout with deformed heads in 38% of our sampling sections.

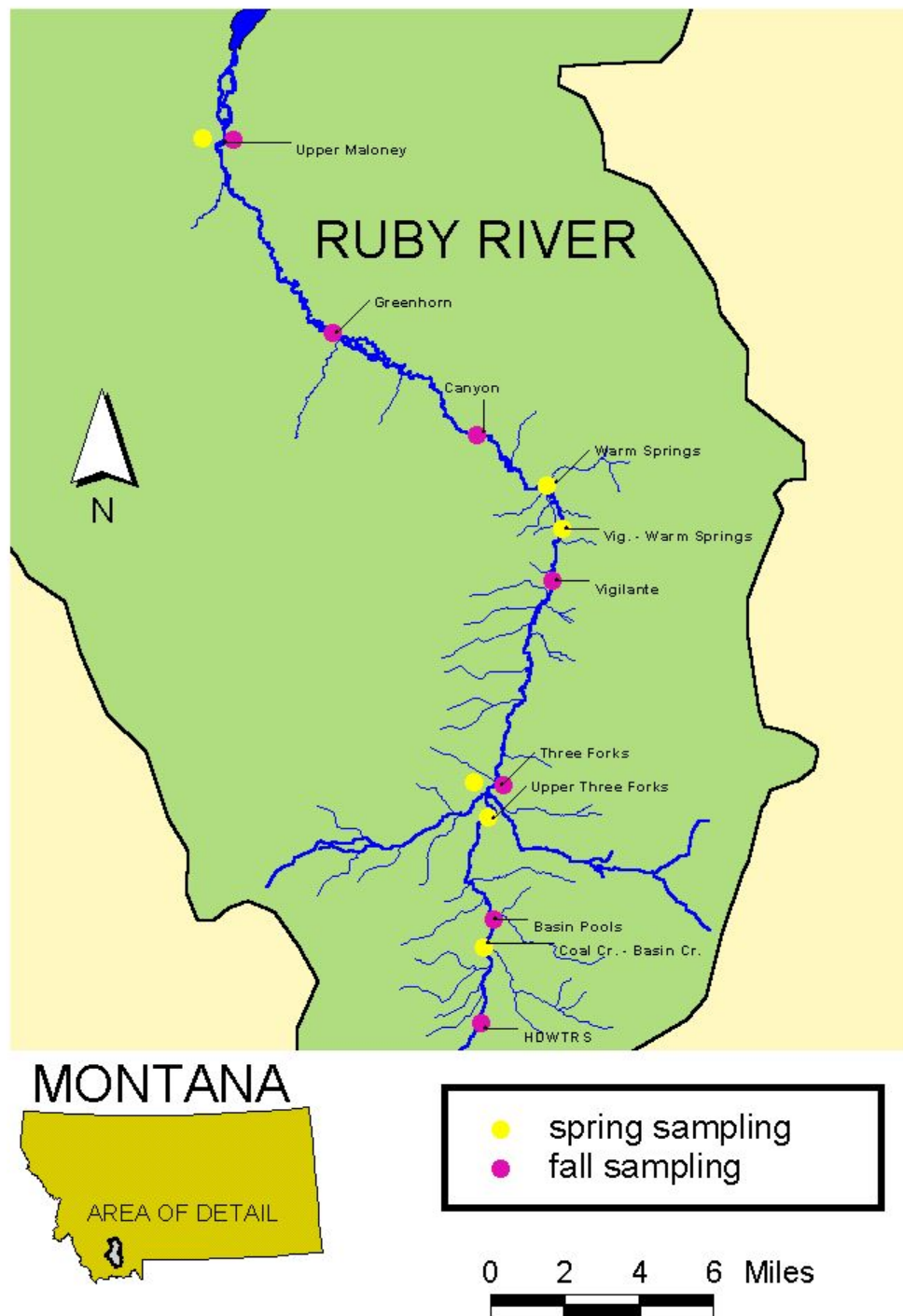


Figure 16. Seasonal sampling locations within the upper Ruby River (2003).

Table 5. Summary of spring sampling results from the upper Ruby River (2003).

Section	Species	N	mean length(in.)	mean weight(lb.)
Coal Cr.- Basin Cr.	rainbow trout	143	8.9 (± 0.2)	0.29 (± 0.01)
Upper Three Forks	rainbow trout	37	10.3 (± 0.4)	0.46 (± 0.05)
Three Forks	rainbow trout	29	10.4 (± 0.4)	0.48 (± 0.05)
Three Forks	grayling	2	10.9 (± 0.6)	0.44 (± 0.06)
Upper Maloney	rainbow trout	35	12.7 (± 0.3)	0.74 (± 0.05)
Upper Maloney	brown trout	88	13.6 (± 0.3)	0.98 (± 0.05)
Vig – Warm Springs	rainbow trout	192	11.6 (± 0.1)	0.59 (± 0.02)
Vig – Warm Springs	grayling	4	11.8 (± 0.2)	0.49 (± 0.02)
Vig – Warm Springs	brown trout	16	17.2 (± 0.3)	1.91 (± 0.11)
Warm Springs	rainbow trout	54	11.0 (± 0.2)	0.56 (± 0.03)
Warm Springs	brown trout	3	17.8 (± 0.4)	2.04 (± 0.30)

Table 6. Summary of fall sampling results from the upper Ruby River (2003).

Section	Species	N	mean length(in.)	mean weight(lb.)
Canyon	rainbow trout	243	9.8 (± 0.2)	0.41 (± 0.02)
Canyon	brown trout	41	16.4 (± 0.3)	1.70 (± 0.08)
Canyon	grayling	236	10.1 (± 0.1)	0.30 (± 0.01)
Greenhorn	rainbow trout	55	12.6 (± 0.2)	0.76 (± 0.04)
Greenhorn	brown trout	406	13.1 (± 0.1)	0.99 (± 0.04)
Greenhorn	grayling	132	10.2 (± 0.1)	0.32 (± 0.01)
Hdwtrs (MF)	rainbow trout	19	8.3 (± 0.2)	0.19 (± 0.02)
Hdwtrs (MF)	grayling	53	4.1 (± 0.2)	0.05 (± 0.01)
Basin Pools	rainbow trout	8	9.6 (± 0.9)	0.36 (± 0.10)
Basin Pools	grayling	183	7.8 (± 0.1)	0.17 (± 0.01)
Three Forks	rainbow trout	137	9.1 (± 0.2)	0.32 (± 0.02)
Three Forks	grayling	308	10.0 (± 0.1)	0.29 (± 0.01)
Upper Maloney	rainbow trout	38	13.2 (± 0.4)	0.91 (± 0.06)
Upper Maloney	brown trout	66	12.3 (± 0.5)	0.94 (± 0.10)
Upper Maloney	grayling	3	9.9 (± 0.4)	0.27 (± 0.03)
Vigilante	rainbow trout	137	11.1 (± 0.2)	0.57 (± 0.03)
Vigilante	grayling	359	10.2 (± 0.1)	0.33 (± 0.01)

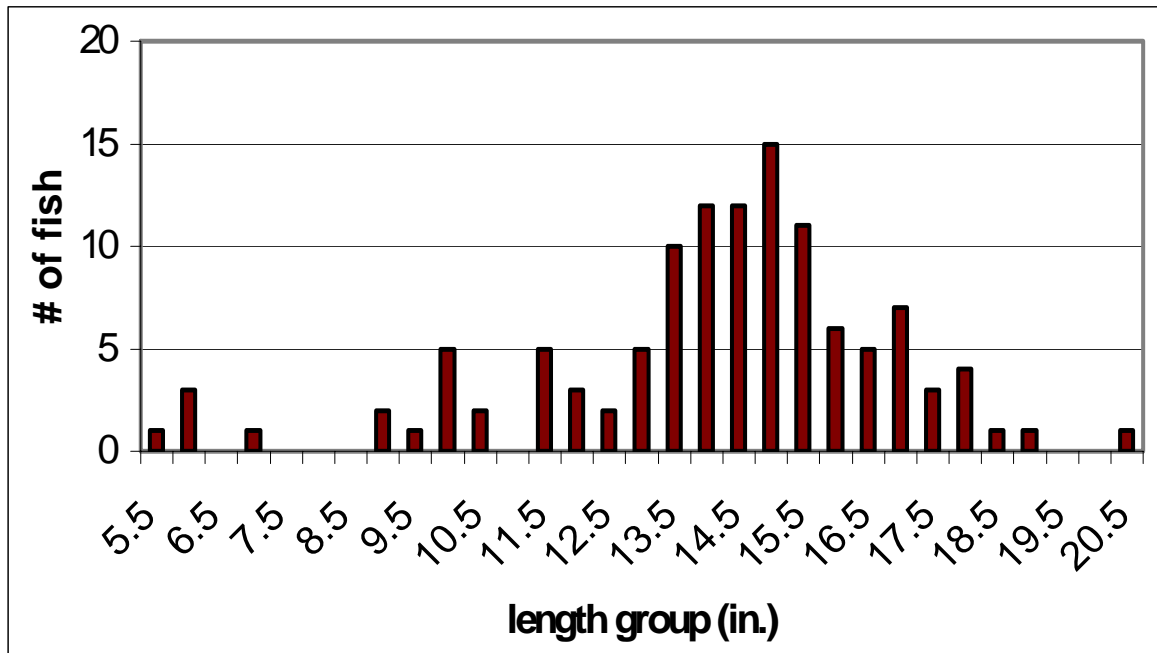


Figure 17. Length frequency distribution of brown trout captured during spring sampling in the upper Ruby River (2003).

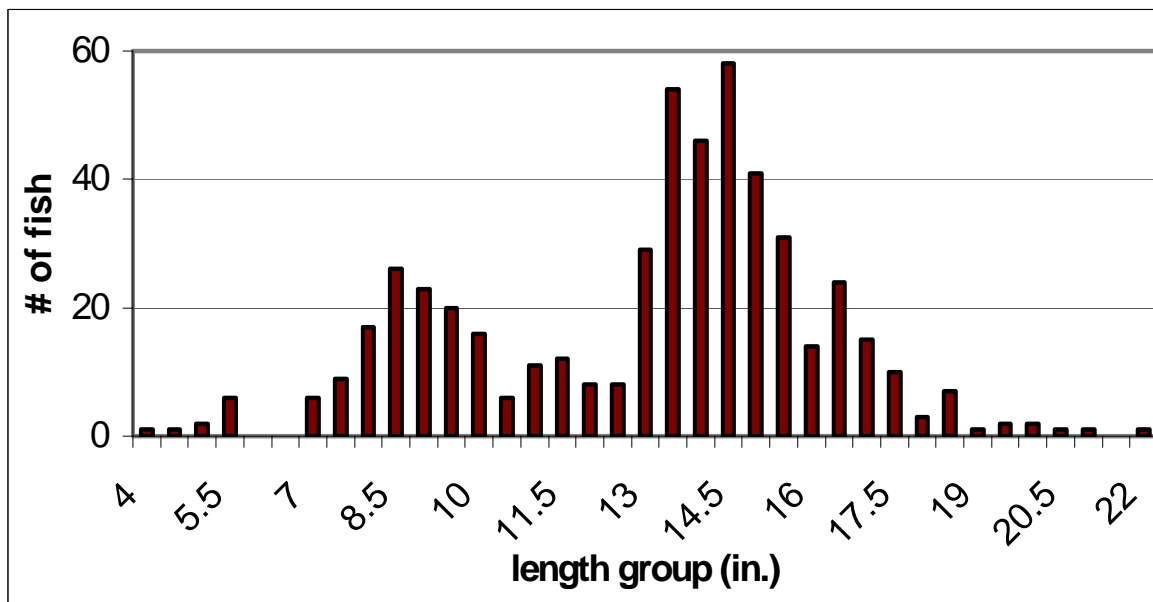


Figure 18. Length frequency distribution of brown trout captured during fall sampling in the upper Ruby River (2003).

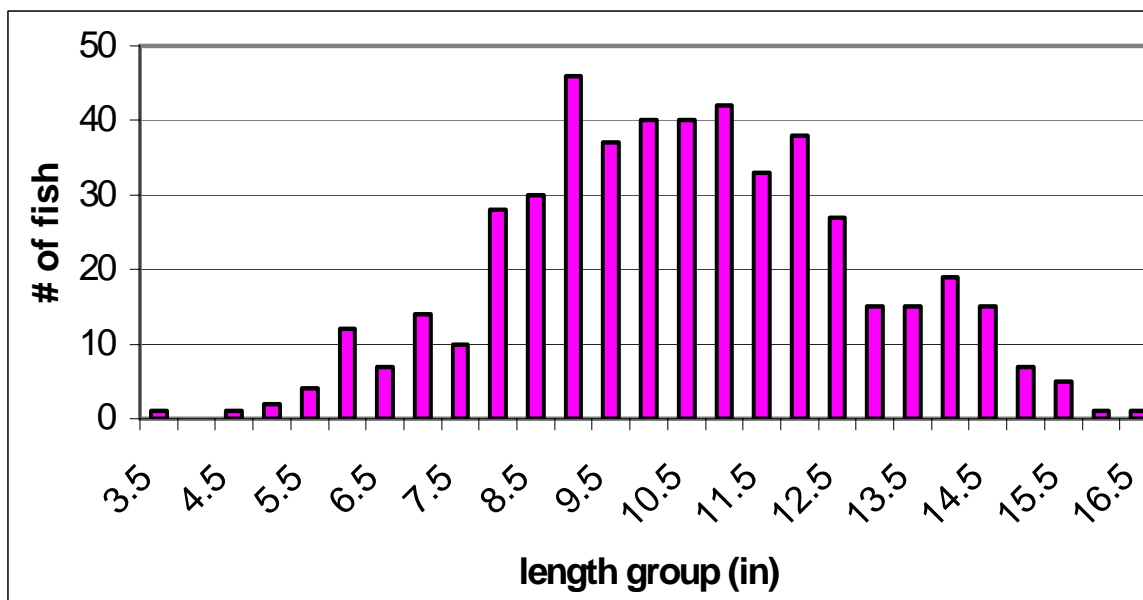


Figure 19. Length frequency distribution of rainbow trout captured during spring sampling of the upper Ruby River (2003).

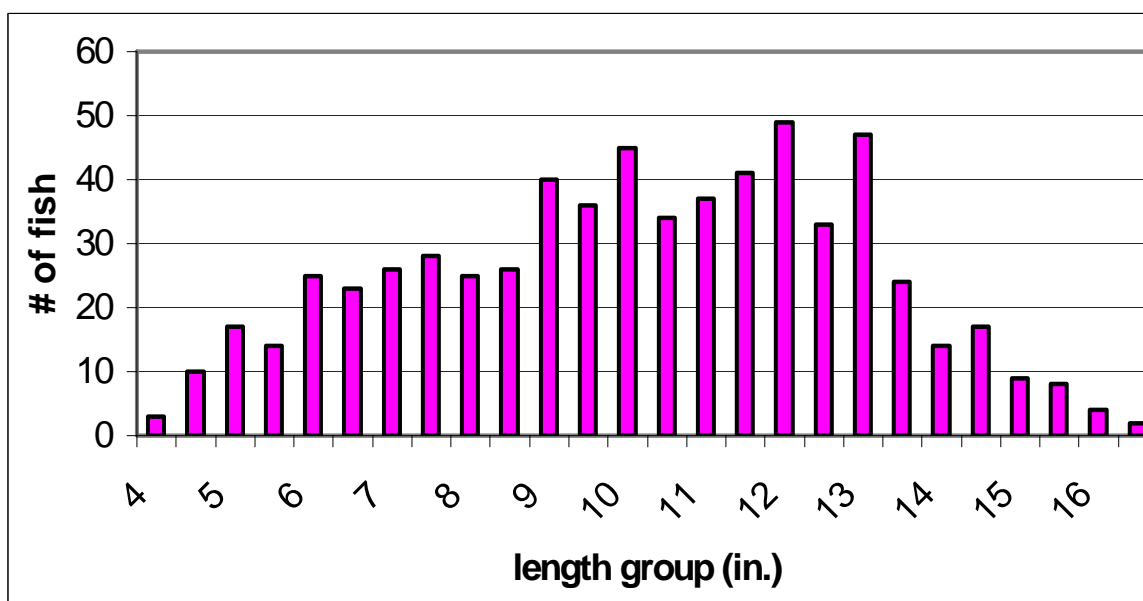


Figure 20. Length frequency distribution of rainbow trout captured during fall sampling of the upper Ruby River (2003).

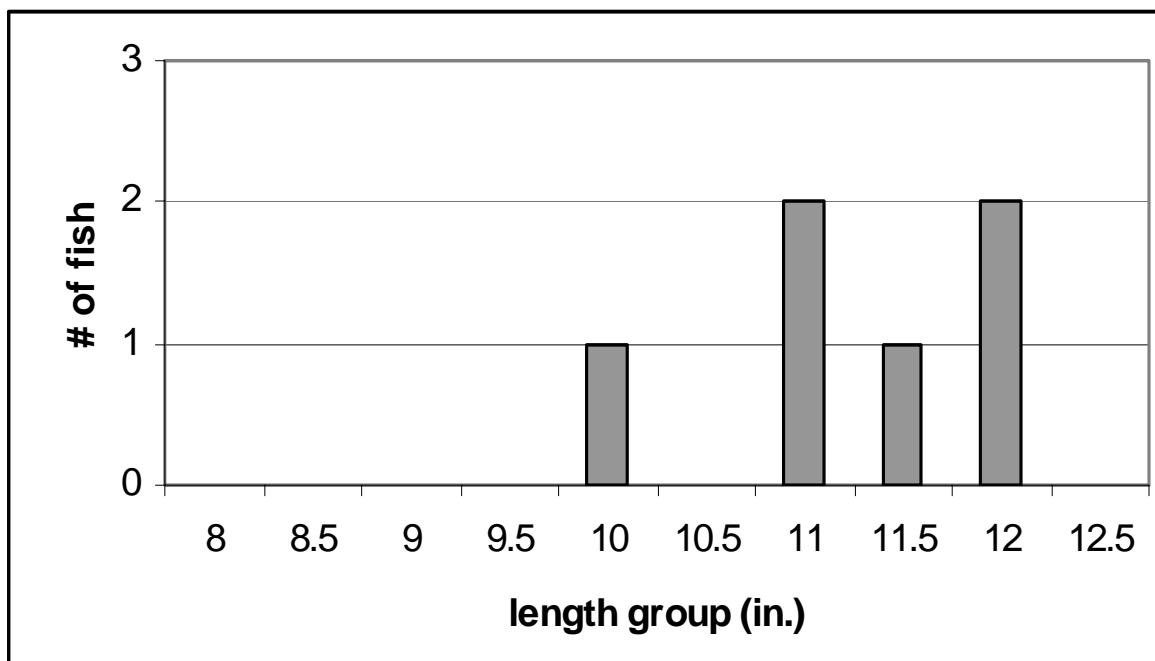


Figure 21. Length frequency distribution of Arctic grayling captured during spring sampling of the upper Ruby River (2003).

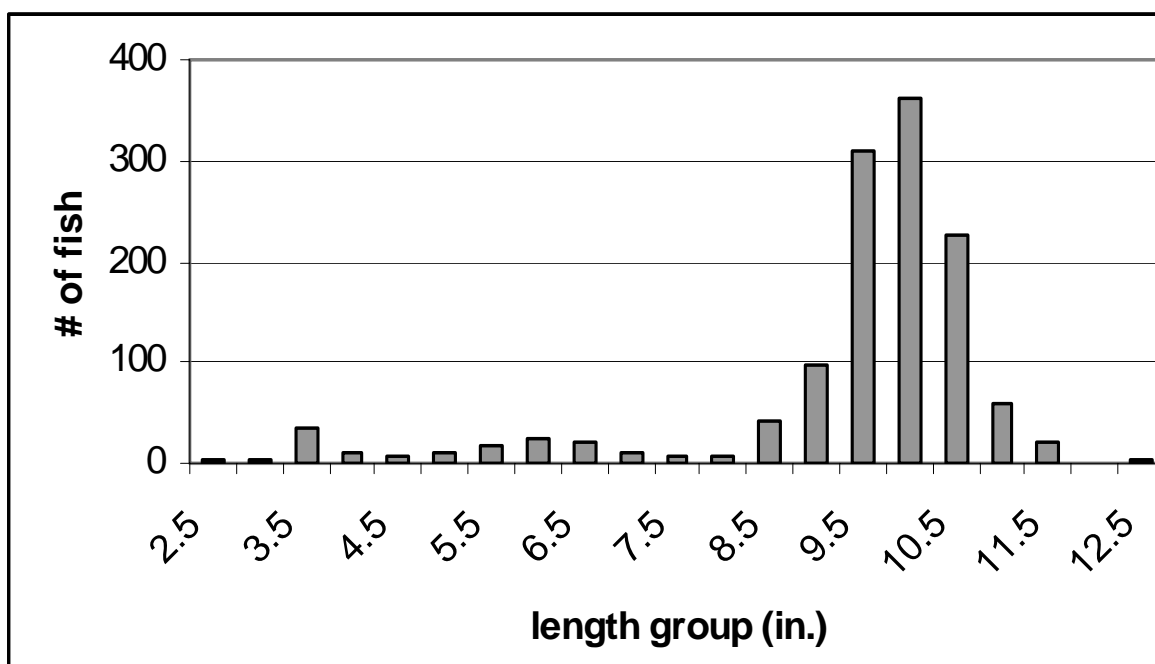


Figure 22. Length frequency distribution of Arctic grayling captured during fall sampling of the upper Ruby River (2003).

Table 7. Summary of results for occurrence of whirling disease in rainbow trout within the upper Ruby River sampling sections (2003). DFH = deformed head.

section	# of rainbows captured	# of rainbows with DFH	percentage
Canyon	244	146	60%
Warm Springs	54	20	37%
Greenhorn	55	10	18%
Vig – Warm Springs	192	33	17%
Vigilante	137	10	7%

Discussion

The continued low numbers of Arctic grayling captured during spring sampling is a cause for concern. We believe that this is an indication of either the inability of hatchery fish to orient themselves in a foreign system and find suitable winter habitat or the low availability of wintering habitat. Grayling over-winter in relatively deep pools. If the reintroduction of fluvial Arctic grayling to the upper Ruby River is to be successful this potentially limiting factor should be investigated and addressed. In response to this trend we selected stocking locations that are farther upstream than locations we used in the past. This decision was made in part due to the presence of several high quality pools created from beaver activity upstream of Poison Creek. Our hope was that by stocking upstream of these beaver pond complexes, the stocked grayling would use these areas to survive the winter.

An extremely encouraging result from our fall sampling is the presence of relatively high numbers of yoy Arctic grayling in the middle fork of the upper Ruby

River. Our surveys show that many of these fish had migrated downstream into areas with beaver pond complexes that hopefully will provide the habitat necessary to survive the winter. As our ability to produce yoy grayling from RSIs improves, this age class of fish will make up a larger portion of the population.

The presence of whirling disease in upper Ruby River rainbow trout remains high. However, it does not seem to be providing a niche to the Arctic grayling stocked in the drainage. Reductions in the numbers of rainbow trout due to whirling disease may allow a wild population of fluvial Arctic grayling to utilize the niche previously occupied by rainbow trout, increasing their chances of becoming established.

Our efforts to restore a fluvial Arctic grayling population to the upper Ruby River in 2003 were both encouraging and successful. We used some new techniques and we gathered much new information. If our efforts are to be successful we must continue to apply new and applicable techniques to the process. Only through this growth process can we hope to obtain the goal of expanding the range of fluvial Arctic grayling in Montana.

Appendix

Stream discharge and temperature data for the upper Ruby River (2003)

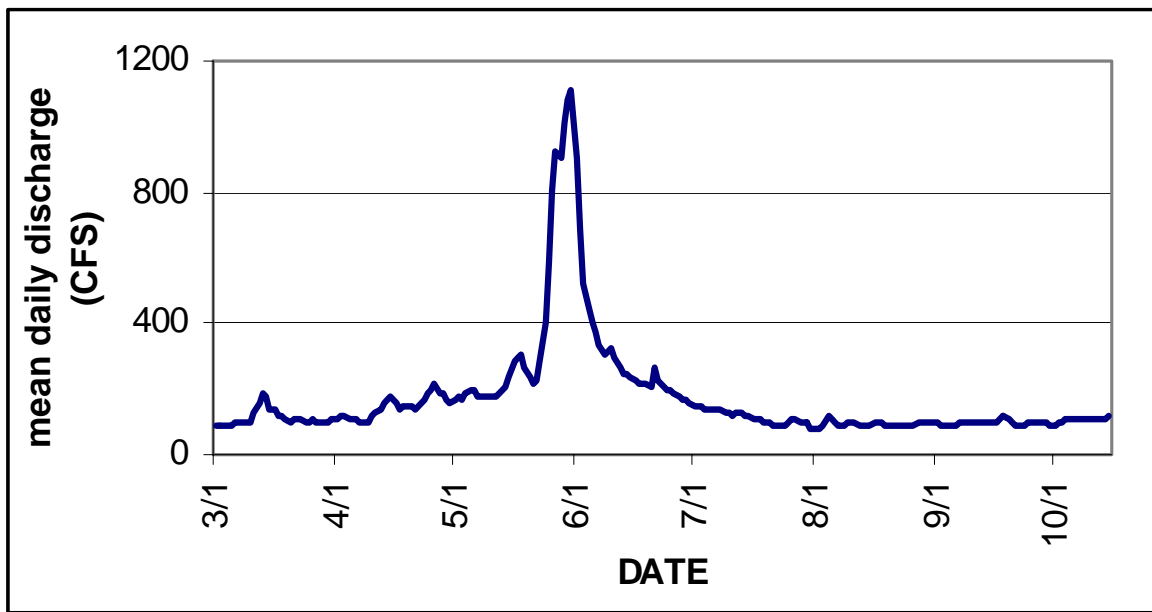


Figure 23. Mean daily discharge data for the upper Ruby River (2003). Data was collected at and downloaded from USGS monitoring station 6019500.

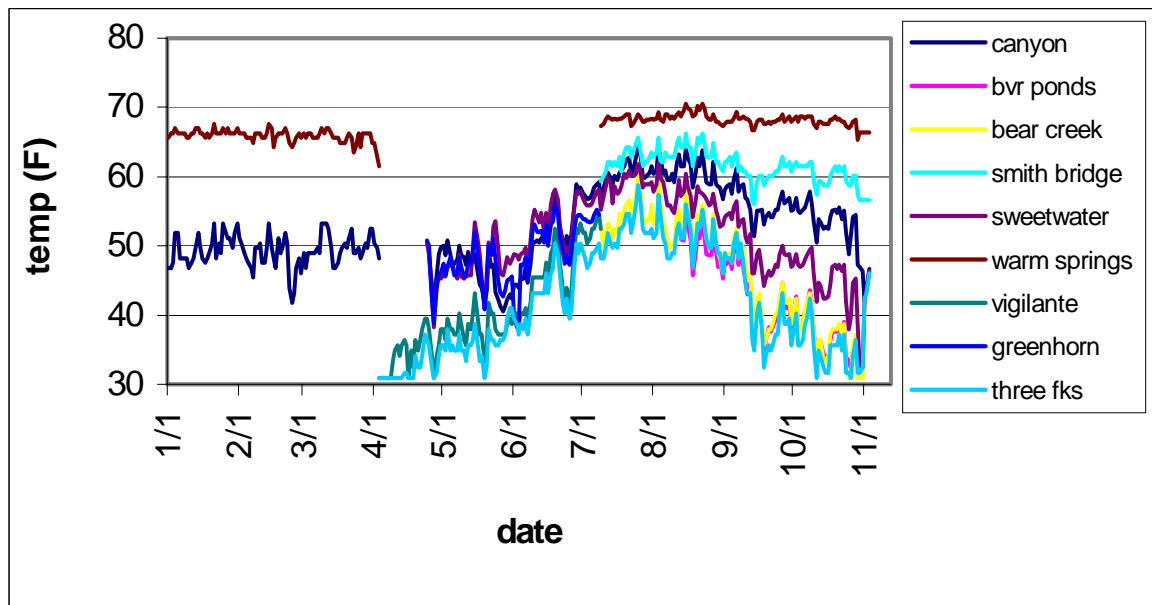


Figure 24. Daily minimum stream temperatures collected from 9 locations in the upper Ruby River (2003). See Figure 27.

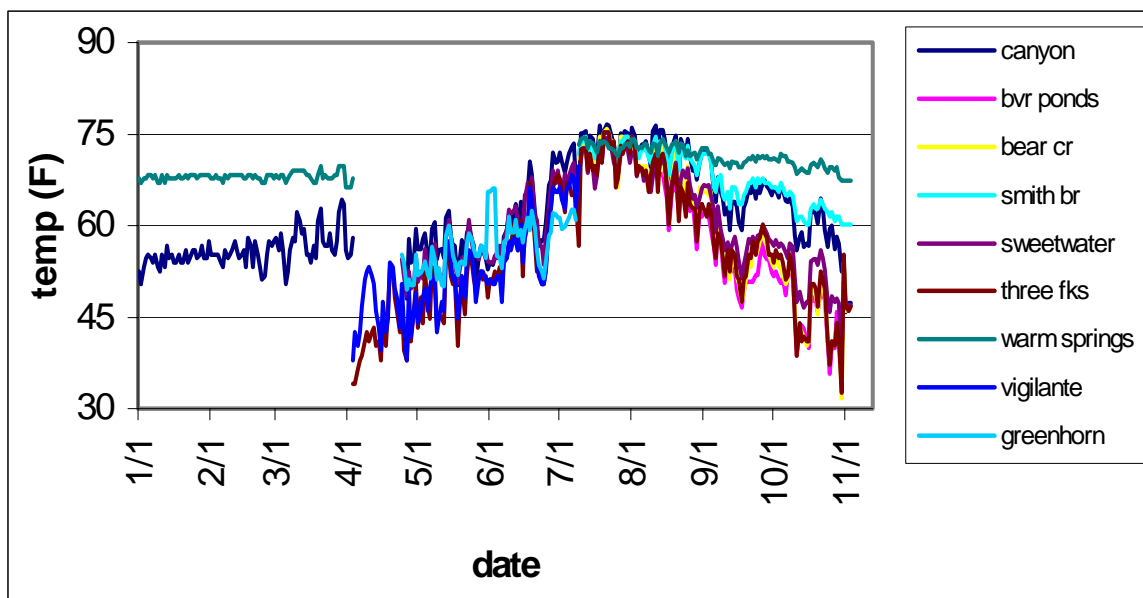


Figure 25. Daily maximum stream temperatures from 9 locations in the upper Ruby River (2003). See Figure 27.

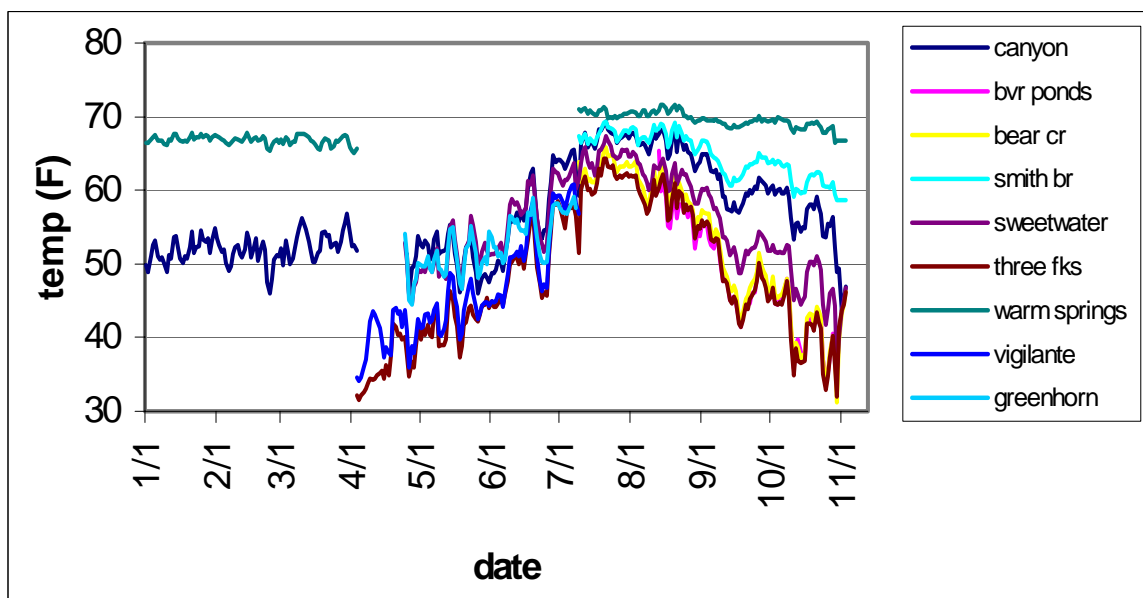


Figure 26. Daily mean stream temperatures from 9 locations in the upper Ruby River (2003). See Figure 27.

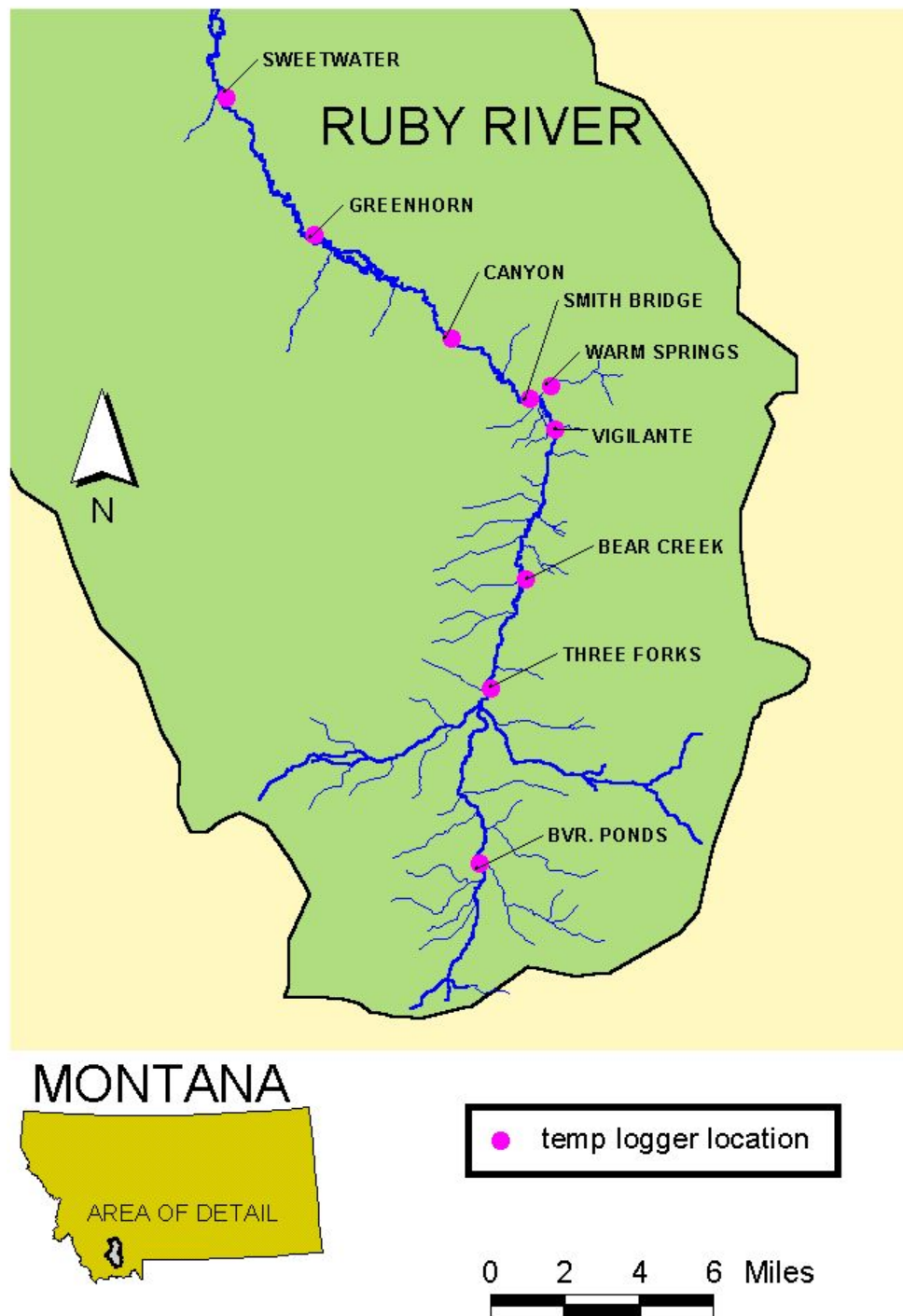


Figure 27. Locations used for stream temperature monitoring in the upper Ruby River (2003).

ACKNOWLEDGEMENTS

The amount of work in 2003 that went into understanding the dynamics and viability of reintroducing fluvial Arctic grayling into the upper Ruby River was extensive. This effort was made possible by the following people: Greg Gibbons, Zach Byram, Scott Lula, Tim Weiss, John Hoerning and Tracy Elam provided valuable assistance in the field. Dick Oswald provided data from his Ruby River sampling sections and valuable guidance and technical assistance. Steve Dalby, Lee Nelson, Chris Riley, and Pete Bengeyfield provided equipment and advice for the remote site incubator study. Jack Boyce, Jim Peterson, Ken Staigmiller, and Gary Shaver shared their extensive knowledge of grayling egg-rearing techniques and disease issues. Turner Enterprises, specifically Carter Kruse, Justin Hedgecock, and Sam Averitt provided valuable assistance and support to the telemetry study. Ron Zitzo and Matt Toner assisted in the maintenance of the grayling brood stock and the transportation of fish from the Bozeman Fish Tech Center and Axolotl Lakes. Bob Braund, Dave Ellis and Gary Shaver assisted in maintenance of the grayling brood stock and transported fish from the Bluewater State Fish Hatchery to the upper Ruby River. They also provided valuable information on suitable stocking locations. Ken McDonald and Bob Snyder provided valuable support and guidance for this effort. We'd also like to thank all the private landowners along the river that provided us with stream access and information. The United States Forest Service (USFS) provided support and housing at the Vigilante Station for crews working on the remote site incubator study.

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